SCIENTIFIC AMERICAN SUPPLEMENT No. 674

Scientific American Supplement, Vol. XXVI., No. 674.
Scientific American, established 1845.

NEW YORK, DECEMBER 1, 1888.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

AMPERE.

STATUE IN BRONZE BY CHARLES TEXTOR—LATELY UNVEILED AT LYONS BY PRESIDENT CARNOT.

THE NEW STATUE TO AMPERE, AT LYONS, FRANCE.

The President of the French republic, M. Carnot, attended the unveiling of the statue of Ampere on the old Henry IV. Square, on the morning of October 8. Three addresses were delivered by Messrs. Gailleton, mayor of Lyons, Tessier, delegate from the Academy of Lyons, and Corme, of the Institute, sent as a delegate by his colleagues of the Academy of Sciences. The orators enumerated the various discoveries which have made the name of Ampere illustrious.

The municipal council of Lyons, with the mayor as president, voted in 1881 the erection of the statue of Andre Marie Ampere, author of the theory of dynamic electricity. During that same year, 1881, there was a competition of all the French sculptors; the laureate, Mr. Charles Textor, a pupil of the "Ecole la Martiniere," was charged by the city of Lyons with the execution of the statue. The pedestal is the work of Mr. J. Dubuisson, architect.

Ampere is represented seated, his face raised a little and full of expression; under that broad forehead some great problem is being solved. Thought, the mistress of a long-sought solution, is discovering new horizons.

Aside from those qualities which can be called decorative, let us say here one thing in honor of the artist who conceived this remarkable work, to the effect that he wished to be true, and was so.

The Place Henry IV. is now called Place Ampere.—*Le Monde Illustre.*

AMPERE.

Ampere, Andre Marie, the founder of the science of electro-dynamics, was born at Lyons in January, 1775. The following interesting sketch of his life is given in the Encyclopædia Britannica: Ampere took a passionate delight in the pursuit of knowledge from his very infancy, and is reported to have worked out lengthy arithmetical sums by means of pebbles and biscuit crumbs before he knew the figures. His father began to teach him Latin, but left this off on discovering the boy's greater inclination and aptitude for mathematical studies. The young Ampere, however, soon resumed his Latin lessons, to enable him to master the works of Euler and Bernouilli. In later life he was accustomed to say that he knew as much about mathematics when he was eighteen as he ever knew; but his reading embraced nearly the whole round of knowledge, history, travels, poetry, philosophy, and the natural sciences. At this age he had read the whole of the Encyclopedie, and with such interest and attention that he could repeat passages from it fifty years after. When Lyons was taken by the Army of the Convention in 1793, the father of Ampere, who, holding the office of *juge de paix*, had stood out resolutely against the previous revolutionary excesses, was at once thrown into prison, and soon after perished on the scaffold. This event produced such an impression on the susceptible mind of Ampere that he continued for more than a year in a state little removed from idiocy. But Rousseau's letters on botany falling into his hands, the subject engrossed him, and roused him from his apathy. His passion for knowledge returned. From botany he turned to the study of classic poets, and to the writing of verses himself.

About this time (1796) an attachment sprang up, the progress of which he naively recorded in a journal (Amorum). In 1799 he was happily married to the object of his attachment. From about 1796 Ampere gave private lessons at Lyons in mathematics, chemistry, and languages; and in 1801 he removed to Bourg, as professor of physics and chemistry, leaving his ailing wife and infant son at Lyons. His wife died in 1804. After two years' absence he returned to Lyons, on his appointment as professor of mathematics at the Lyceum. His small treatise, *Considerations sur la Theorie Mathematique du Jeu* (Lyons, 1802), in which he successfully solved a problem that had occupied Buffon, Pascal, and others, and demonstrated that the chances of play are decidedly against the habitual gambler, attracted considerable attention. It was this work that brought him under the notice of M. Delambre, whose recommendation obtained for him the Lyons appointment, and afterward (1805) a subordinate position in the Polytechnic School at Paris, where he was elected professor of analysis in 1809. Here he continued to prosecute his scientific researches and his multifarious studies with unabated diligence. He was admitted a member of the Institute in 1814. It is on the service that he rendered to science in establishing the relations between electricity and magnetism, and in developing the science of electro-magnetism, or, as he called it, electro-dynamics, that Ampere's fame mainly rests.

On the 11th of September, 1820, he heard of the discovery of Professor Oersted, of Copenhagen, that a magnetic needle may be deflected by a Voltaic current. On the 18th of the same month he presented a paper to the Academy, containing a far more complete exposition of the phenomenon, which he had in the interval investigated by experiment, and showing that magnetic defects can be produced, without magnets, by aid of electricity alone. In particular he showed that two wires connecting the opposite poles of a battery attract or repel each other according as the currents pass in the same or in opposite directions. According to the theory of magnetism which Ampere's subsequent investigations led him to adopt, every molecule of magnetic matter is acted on by a closed electric current, and magnetization takes place in proportion as the direction of these currents approaches parallelism. The whole field thus opened up he explored with characteristic industry and care. He anticipated the invention of the electric telegraph, having suggested in 1821 an apparatus of the kind with a separate wire for each letter. Late in life he prepared a remarkable work on the classification of the sciences, which was published after his death. In addition to this and one or two works of less importance, he wrote a great number of memoirs that appeared in scientific journals. He died at Marseilles in June, 1836. The great amiability and child-like simplicity of Ampere's character are well brought out in his *Journal et Correspondence*, published by Madame Chevreux (Paris, 1873).

A German paper says that a company has been formed to manufacture watches to be run by electricity instead of a spring.

BENJAMIN B. CHAMBERLAIN.

Benjamin B. Chamberlain was born at Keeseville, N. Y., March 13, 1831. He was the son of the Rev. Parmalee Chamberlain, a Methodist clergyman formerly well known in New York, and Governor Chamberlain and President Chamberlain, of Bowdoin College, sprung from the same family tree. He was graduated from the Irving Institute, and also attended the Peekskill Military Academy, where, with General Adam Badeau, he carried off the honors for scholarship and general excellence. After leaving school, he was apprenticed to Benj. J. Lossing, then an engraver in New York, and subsequently went to Cincinnati to embark in business for himself. At the time of Morgan's raid he served on the Home Guard for one year, but was retired on account of a slight deafness. Meeting with success, about 1865 he returned to New York, where the field was broader.

While in Cincinnati, he turned his attention to collecting, his first hobby being medallions, and after his return to New York he took up the study of minerals, making a specialty of collecting those of New York and vicinity. For this work he had exceptional facilities, as the Fourth Avenue improvement was then in progress, and blasting was going on in many parts of the city now built over. Such was his enthusiasm that he often neglected his business to watch the operations of the blasters. His researches extended into the suburbs, and his collection contained many fine specimens from the Delaware, Lackawana, and Western and West Shore tunnels, and from the mineral localities of Staten Island and Westchester County.

He leaves one collection at the Nyack Library. His foreign collection he sold recently to Mr. Edward A. Pearson for the new school at Cloudland, New Jersey. The principal work of his life was his collection of New York Island minerals, now deposited in the American Museum of Natural History. His contributions to local mineralogy have been published from time to time in the *Transactions* of the New York Academy of Sciences, and during the past few months his paper on the "Mineralogy of New York Island," a pamphlet of 25 pages, appeared in the same source, and has been reprinted in separate form.

He was a fellow and curator of the New York Academy of Sciences, treasurer and one of the founders of the New York Mineralogical Club, the Agassiz Association of Nyack, the West End Literary and Scientific Society.

He was a man of considerable artistic talent, had exhibited pictures at the Academy of Design, and made a large number of paintings, both in water and oil, of interesting suburban scenery. As a sketcher he was quick and accurate, and his keen sense of humor furnished no end of amusement to his host of friends. He leaves albums filled with sketches made by him during his service at the time of Morgan's raid and on his many jaunts in search of specimens.

He was very companionable, full of pleasing anecdotes, and cheerful under all circumstances, even when suffering pain. Among the scientific, literary, and æsthetic circles of New York he had hosts of friends.

He had been ailing for some years, but his death, which occurred at the home of his brother, Mr. E. H. Cole, at Nyack, on October 13, was very sudden. At noon he had a severe hemorrhage, and at half past two died, almost without a struggle. The cause of his death is believed to have been rheumatism of the heart.

A NEW CONSTITUENT OF LIVER OIL.*

By H. Marpmann.

The author states that by washing liver oil with 95 per cent. alcohol he has obtained a peculiar substance, which is easily soluble in water and insoluble in alcohol, ether, and benzene. According to the age and color, liver oil dissolves more or less readily in alcohol; but even when sixty parts of alcohol are used to one pint of oil, a perfect solution is not obtained, there being always a residue of insoluble fat acids, which are dissolved by hot alcohol and by ether, but not by cold alcohol. As the substance in question is somewhat soluble in hot alcohol, the last traces of the insoluble compounds were washed out by means of cold alcohol, and the material worked upon was not the solution of oil in alcohol, but the portion washed out of it on account of its insolubility.

This insoluble residue, after repeated shaking with alcohol, was mixed with water and filtered. The portion soluble in water was, however, so small that the author is only able at present to give the general reactions of the aqueous solution. It had a faintly acid reaction, rotated polarized light to the left, gave with lead acetate and with tannic acid a slight turbidity, and was not altered by potassium ferrocyanide. A dilute solution gave with ferric chloride no reaction, but a concentrated solution assumed with it a dark yellow color, which upon boiling became blood red, and again yellow upon cooling. The solution upon boiling was not changed by strong nitric acid, ammonia, or potassium hydrate. On the other hand, it reduced alkaline copper solution. Upon mixing the solution with orcin and hydrochloric acid in a porcelain dish, and evaporating on a water bath to dryness, there remained a brown residue, having a metallic luster. This dissolved in alcohol with a dark brown color, and the solution was colored gray brown by ammonia. By this last reaction this constituent of liver oil soluble in water is distinguished from varieties of gum, since gum gives with orcin a green residue, that dissolves in alcohol with a greenish yellow color, and this solution when treated with ammonia is colored yellow, with a tinge of greenish violet.

According to the rotatory power of the new substance and its behavior toward Fehling's solution, it might have been supposed to be gum or an albuminoid or a sugar. For its qualitative distinction from any of these compounds the author found the orcin test most suitable, and he therefore describes the reaction somewhat in detail.

Orcin is the chromogen of various coloring matters, and is obtained from species of *Roccella* and *Variolaria* by boiling with milk of lime, and extraction of the neutralized and evaporated filtrate with alcohol, from which it crystallizes out in colorless crystals. The orcin is freely soluble in water, and is readily altered on the addition of hydrochloric acid. Upon evaporating such a solution on a water bath, the residue is of a beautiful red color; this residue dissolves in alcohol with a rose color, which is changed to a very beautiful violet upon the addition of a few drops of ammonia solution. Small quantities of organic substances modify these color reactions very considerably, so that orcin constitutes an important reagent for such bodies, especially for carbohydrates.

Constant colorations are also obtained upon boiling a dilute solution of a carbohydrate with an equal volume of hydrochloric acid and about 1 per cent. of orcin, and afterward adding alcohol and ammonia. But these reactions do not take place so smoothly as those obtained when evaporation is practiced.

The author prepared a solution of one gramme of orcin in 100 c. c. of pure hydrochloric acid, of which he placed about 0·5 c. c. upon a porcelain dish, then added about an equal quantity of the substance to be tested, and evaporated upon a water bath. As soon as this small quantity of liquid became warm, the color reaction began, the evaporated layer becoming colored at the margin. When it was dry alcohol was added, which dissolved the residue more or less completely. This alcoholic solution had a constant color for each substance, which upon the addition of a few drops of ammonia solution was altered more or less. Strong oxidizing agents, such as nitric acid, give very strong colorations with orcin, on which account such additions are to be avoided.

In the following table the color reactions of orcin with various subestances tested are described:

	Evaporation Residue.	Solution in Alcohol.	Addition of Ammonia.
Gum Arabic	Green	Green-yellow	Green-yellow violet.
Gum Tragacanth	Green-black	Green-yellow	Brown.
Gum Senegal	Greenish blue	Green-yellow	Green-yellow
Potato Starch	Red	Light-brown	Violet-yellow
Maranta Starch	Red	Brown	Brown.
Triticum Starch	Yellow-red	Light-brown	Brown.
Milk Sugar	Brown-red	Yellow-brown	Greenish-brown.
Beet Sugar	Brown	Yellow-brown	Brown.
Cane Sugar	Brown	Yellow-brown	Brown.
Gelatin	Red	Yellow-red	Violet.
Pepsin	Yellow	Yellow	Dark-yellow.
Pancreatin	Brown	Light-brown	Rose-violet.
Albumen, fresh	Yellow-brown	Light-brown	Brown.
Albumen, boiled, dissolved in Pepsin	Yellow	Light-brown	Brown.
Albumen, boiled, dissolved in Pancreatin	Brown	Light-brown	Brown-violet.
Residue from alcoholic solution of Liver Oil	Brown	Light-brown	Brown-green.
Pure Orcin	Red	Rose	Violet.

According to this comparison, the residue from liver oil showed most resemblance to pancreatin and albumen that had been dissolved by pancreatin. This suggested the idea of seeking the new substance in fresh pancreatic liquor.

Fresh aqueous pressings from pancreas glands were precipitated with alcohol, the precipitate washed with alcohol, then dissolved in water and again precipitated, washed, and redissolved in water. The resulting solution rotated a polarized ray to the left and reduced alkaline copper solution. By evaporating over sulphuric acid a non-crystalline residue was obtained. It was therefore considered probable that the two substances from liver oil and pancreatic juice were identical, and this assumption was made tolerably certain by a comparison of the influence of the two substances upon fixed oils. A few cubic centimeters of the solutions mixed with any of the fatty oils acted so that the oil could be temporarily emulsified with half its volume of water, and after several hours the oil did not separate pure, but with a somewhat milky turbidity.

The author states that he has found this new substance in all the samples of liver oil examined, both in the white oils and in the darkest varieties, from the most diverse commercial sources. He thinks it might be present in fresh livers in larger quantity, since liver oils deposit a quantity of mucus upon standing. But at present he has not examined any perfectly fresh oils, and cannot therefore speak with certainty upon this point.

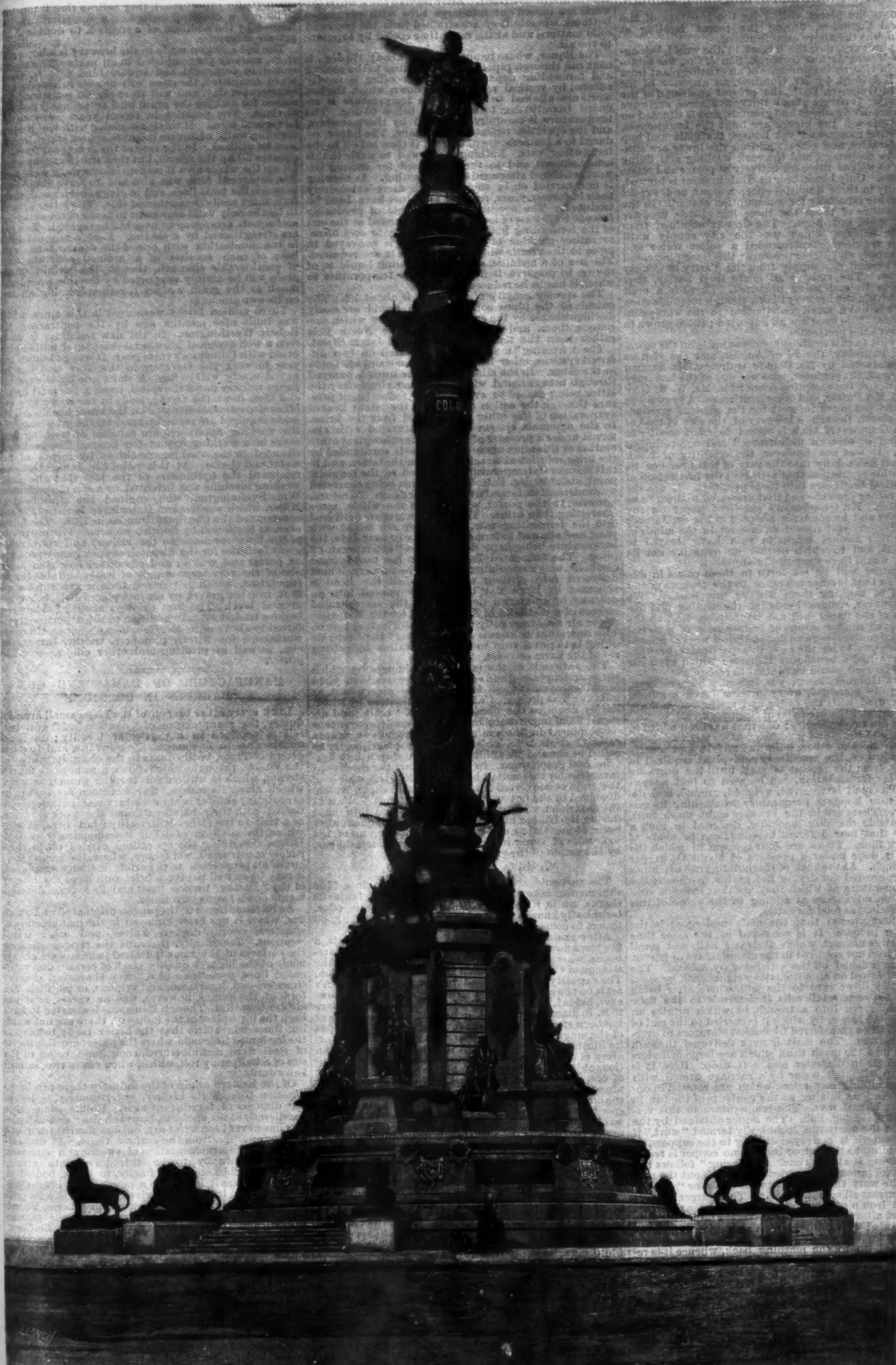
* From the *Pharmaceutische Centralhalle*, August 23; *Pharmaceutical Journal.*

THE NEW MONUMENT TO COLUMBUS AT BARCELONA.

The corporation of the city of Barcelona have lately erected a magnificent monument to the memory of Columbus, of which we present herewith an engraving from *La Ilustracion*, of that city. It was in Barcelona that Columbus presented himself before the court of Spain on his return from his first voyage to America.

The new monument is the work of D. C. Buigas Monraba, and is very highly spoken of for its beautiful proportions and artistic merits. It has a height of 190 ft. and is composed chiefly of stone. It was built at a cost of $225,000. It rests upon a platform raised about 3 ft. above the ground, and flanked by six lions. Upon this platform is the lower part of the pedestal, which is ornamented with the shields of the various provinces of Spain. Between the shields are bronze panels having in alto-relievo various scenes from the life of Columbus, among which are: the arrival of Columbus at the Convent Rabida; the presentation of Columbus to the Catholic monarchs at Cordova; the controversy between Columbus and the council assembled at the court of St. Stephen in Salamanca; the interview between Columbus and Ferdinand and Isabella at Santa Fe, before Grenada; the embarkation of Columbus from the port of Palos on his first voyage of discovery; the landing of Columbus in America; his formal taking possession of the newly discovered country in the name of the Catholic sovereigns; the arrival of Columbus at Barcelona on his return from his first voyage.

The upper part of the pedestal is adorned with various sculptured figures emblematic of the provinces of Spain and of eminent personages connected with the great enterprise of Columbus. The pedestal is surmounted with a column some 60 ft. in height, elaborately ornamented at its upper part, on which is placed a massive princely crown, on the top of which rests a representation of the globe, and upon this stands a colossal statue of Columbus with outstretched arm pointing to the land which he was the first to discover.



THE NEW MONUMENT TO COLUMBUS, BARCELONA, SPAIN.—DESIGNED BY D. C. BUIGAS MONRABA.

THE ST. JAMES'S GATE BREWERY, DUBLIN.

AMONG the places visited by the Institute of Mechanical Engineers, during the recent meeting at Dublin, was the above establishment.

This brewery, now the largest in the world, belonging to Messrs. Arthur Guinness, Son & Co., was established in 1759, by the purchase of an existing plant from a Mr. Rainsford, by Mr. Guinness, an ancestor of Sir Edward Guinness, Bart., the present chairman of the company. It covers about thirty-five acres, exclusive of workmen's dwellings and grounds, and is situated on two levels—on the higher are built the brewhouses, fermenting rooms, and vat houses, the malt and hop stores, stables, and offices; and on the lower are situated the cooperage, and the cask washing and filling sheds, as well as those for delivery of porter and waste products. Only black beer or Dublin stout is brewed, generally in three qualities—porter, stout, and export stout made especially for consumption abroad. In the manufacture of these the three ingredients used are water, malt, and hops. The first is obtained from County Kildare, which was the city supply until modern requirements demanded a softer water and larger supply and higher pressure; this is supplemented by the present city supply from the Vartry in County Wicklow. The malt is all made from barley, that grown in Ireland being preferred. There is a malt house within the brewery limits, though its production of malt is but a small contribution to the whole consumption. The hops are all imported; those grown in Kent have the preference.

The visit to this establishment was made on the morning of Thursday, the 2d of August, and the visitors were conducted by Mr. Claude Guinness, Mr. Samuel Geoghegan, the engineer, who was one of the honorary secretaries of the reception committee, Mr. W. K. Geoghegan, Mr. Purser, and other gentlemen. A brewery as such has not much interest for the general mechanical engineer, though a brewery of the size of that of Messrs. Guinness & Co.'s is bound to elicit wonder in the mind of even an uninstructed and non-technical visitor. It was not, however, the quantity of black beer that flows daily into the vats of this firm nor its world-wide reputation that attracted the Institution of Mechanical Engineers into these precincts. It was the means rather than the end that appeared to them to be admirable. Mr. Geoghegan's excellent paper on the tramways and locomotives adopted in the St. James's Gate Brewery had roused an interest in the minds of men which alcohol might in vain have essayed to stimulate, and to which neither its quantity nor its quality would have successfully appealed.

His paper will be set forth in these pages in due course, so that further reference to the tramways and method of working them will be unnecessary. We may, however, remark here that the reading and discussion of the paper will not improbably lead to the adoption of similar means of transmission of material in general engineering and metallurgical works. Should such turn out to be the case, this particular brewery will have had a beneficent influence which even Sir Wilfrid Lawson would be pleased to recognize.

Messrs. Guinness' brewery is, indeed, a huge concern, wonderfully managed, every process being arranged and executed with the order and method of military movement and the precision of clockwork.

There are two breweries; one that has been added to from time to time, and is consequently rather irregular in plan; in the other, built in 1877–78 and nearly doubled in 1886, the machinery and plant required in brewing, from the receipt of malt until the worts are cooled for fermentation, can be seen to best advantage. The malt is received, weighed, ground, and delivered into hoppers preparatory to mashing by machinery. There are in the brewery eight mash tuns, with outside mashing machines, designed in such a manner that four different brewings can be made at the same time. There are four coppers, in which the boiling is done under a pressure of about 1½ lb. per square inch. At the back of this building are machines recently erected for drying the grains in vacuo; the low temperature at which they are thus dried is considered an advantage as adding to the value of this waste product as food for cattle.

The first process that the malt undergoes is the screening process. It is conveyed at the same time past a large magnet, which abstracts nails and small chips of iron not required in the manufacture of porter. These are brushed off the separator by a band. The malt is weighed on an automatic weigher sack by sack, on its way downward to the mill, where, after being crushed between small rolls, it descends to the floor and is delivered into a trough, in which rotates an Archimedian screw, by which it is carried to the end of the room to be transferred by bucket elevators to overhead receivers. The malt is next delivered through hoppers into the mash tuns, which are large cylinders about 15 ft. in diameter and 8 ft. deep. Here it is stirred up with hot water by a carriage armed with forks, resembling hay rakes, which are rotated in opposite directions, mixing up the contents of the tun in the old-fashioned way. The temperature in this vessel is about 158 deg. Fah. The liquor obtained by the process in the mash tun, technically termed "wort," if of full strength, is conveyed directly to the coppers, or is pumped up to the upper back, if no copper is ready for receiving it at the time. "Sparging" follows the "mashing" process. Its object is to wash out the residue of the wort that adheres to the husks or "goods," and to extract all soluble matter. The sparger consists of radial iron pipes that rotate round the axis of the mash tun, after the manner of a Barker's mill, aspersing the "goods" with hot water. The weaker liquor obtained by further wetting of the malt in the mash tun is pumped up to the mashing back, whence it is returned to the mash tun the next day to repeat its previous experience. The coppers are large oval vessels in which the worts are boiled, hops having been added to them, through what is felicitously called a "hopper." The coppers are heated by coal burnt in a Jukes' self-feeding furnace underneath. These furnaces were constructed in 1878; the bars, forming an endless chain, are arranged to receive coal from hoppers at the front, to travel slowly across the bed and discharge the cinders at the back of the furnace, returning beneath. These furnaces appear to work satisfactorily; the uptakes are surrounded with water jackets to utilize the heat of the escaping gases. The hot water from these jackets is pumped up to a tank, and is delivered to the mash tuns as above described. After leaving the coppers the worts are passed out into large tubs with perforated bottoms, wherein they are strained from the hops and solid matters, and at the same time cooled by exposure to the air.

The liquor, whose temperature is about 170 deg., is next run through pipes for some distance to the cooling and fermenting department. The cooling is mostly effected by vertical refrigerators, down which the hot worts are allowed to run, till the temperature is reduced from 100 deg. to somewhat below 60 deg. The temperature is carefully estimated by thermometers, and the operation repeated if necessary. The liquor, reduced to a temperature of 58 deg., is then led off to the fermenting vats. Nothing is allowed to waste in this establishment, and so the water used for cooling the wort is utilized afterward in the brewing. As brewing is now carried on in summer much more extensively than in former years, freezing machines have been introduced. The cooling plant, capable of producing from 60 to 70 tons of ice per day, is arranged at the end of the fermenting house; it is used only to cool brine, or rather chloride of calcium, which is conveyed in pipes to the vessels where cooling effects are required. The use of a metallic salt in the cooling liquid is, of course, to preserve it fluid at the low temperature to which it has to be reduced.

The specific gravity of the brine is about 1·2. The outside of the pipes conveying this liquid are easily distinguishable by the crust of ice and snow which surrounds them, and is suggestive of the North Pole rather than the temperate latitude of James Street.

The "freezing" machines are operated on two different systems, ether being used in one and ammonia in the other. In the ether system, the brine is pumped through tubes around which the ether circulates; the latter being caused to evaporate by reduction of pressure through the action of a pump, the latent heat of evaporation of the ether is abstracted from the brine. In the ammonia system water is saturated with ammonia under a pressure of 150 lb. The subsequent evaporation of this aqua ammonia in vessels surrounded by the brine solution abstracts heat from the latter, and in this manner its temperature is reduced to the requisite point, about 20 deg. Fah. The ammonia being recovered by condensation, is used over and over again. To return, however, to the porter, which is, on the whole, more interesting than brine. The cooled worts are delivered into the fermenting vats, where they are mixed with yeast and allowed to ferment for three or four days, the temperature being kept down by the "attemperator" pipes. The fermented liquor, which has now become alcoholic, and a stumbling block to the unwary, is next delivered into settling vats, off which the head is skimmed by large flat boards, and poured into an *avernus* of unknown depth, while the concentrated essence of a vast lake of X X exposed for the first time to the air rises fragrantly upon the intoxicating breeze. This operation is known as "cleansing" the beer; its object is to put a stop to the fermentation by getting rid of the barm or yeast.

The rationale of the mysterious changes by which the commonplace grains of barley are made to yield liquid enjoyment is, so far as can be ascertained, as follows: The process of arrested germination by which barley acquires the denomination of "malt" and assumes fiscal importance involves the contemporaneous development in the grain of a nitrogenous substance called "diastase." This inscrutable principle is so called because of its ability to split up starch into dextrine and grape sugar. In the mash tun, the conditions favorable for this action being provided, the starch of the grain is converted into dextrine and sugar, which, dissolved in the hot water, forms the "wort." Part of the dextrine no doubt is further converted into sugar during the boiling in the copper. The subsequent alcoholic fermentation consists in the splitting up of the molecules of sugar into alcohol and carbonic acid gas, by the action of the yeast, thus

$$C_6 H_{12} O_6 = 2 C_2 H_6 O + 2 CO_2$$

The carbonic acid floats over the liquor in a blue shimmering lake; the yeasty froth rises in fantastic shapes, while, if the brew be right, an aromatic odor, technically known as "stomach," foreshadows the good things to come.

After examining the fermenting and settling vats, a few steps downward brought the party into a huge warehouse, where stand some of the 150 great vats for the storage of the stout intended for foreign consumption. The capacity of these splendid examples of the cooper's art is on the average 1,100 hogsheads; one of them, however, holds 1,700. The dimensions of the larger ones are 26 ft. in diameter and 26 ft. in height. Some of the beer has been stored in this room for twelve years. An idea of the magnitude of the resources is given by the favorite illustration of the guides, that every member of an army of 700,000 men could, provided he had no conscientious objection, enjoy a pint of Guinness' best stout out of one single vat in this room. These beautiful amphoras, however, are but slender crocks compared to the one that burst at Meux's brewery, sweeping a whole street with its inhabitants into the river. Its capacity was 720,000 gallons. Something like 6,000 barrels are produced per day, and there is a constant stream of porter flowing through a conduit which, like the jar of Bacchus, never fails of its supply. It is a river whose springs are perennial, and altogether independent of meteorological developments. The dark color of Messrs. Guinness' beer is produced by the use of a proportion of charred malt in the manufacture. It is sold under three different designations. These correspond to variations in the amount of hops added and the point at which fermentation is stopped, so far as ordinary porter and extra stout are concerned. The foreign stout, in addition to an extra supply of hops, which renders it very bitter, is often kept in store for many years before publication. The mild porter is used in Ireland as draught porter; so far as this is concerned, climatic and other conditions of life in that country combine to render unnecessary any provision of an antiseptic character. On this account less hops are used in its construction, with the result that it is milder and more genial than the other varieties—a circumstance which reacts favorably on the rapidity of its consumption. Extra stout, or double X, is designed for the English market, and is fortified by hops to enable it to hold out in the face of possible apathy and indifference. The staff of this firm is not able to afford the stranger any satisfactory information on the subject of treble X. Where it is not a synonym for export stout, they believe that it must be, to borrow a chemical metaphor, a compound radical, formed by the addition of a single X to double X, by private enterprise.

The last addition made to the brewery is a large malt store, scarcely yet completed in all parts. The malt is stored in octagonal and square bins, 68½ ft. deep; when completed, the store will be able to receive 2,000 quarters per day, and will store 120,000 quarters. The reason for making the grain bins octagonal is not very obvious. The practice in recent years leans to the hexagonal form. If this is associated with longitudinal dividing walls, of course it leaves spaces which cannot well be utilized. In the case of the octagonal form the squares fill up the spaces, but then the hexagons would fill up the whole area if no continuous walls were used. The octagonal form was also said to leave more room between the tram lines, and to give a shorter and, therefore, more easily strengthened side. The latter appears to be the only valid argument in favor of the octagonal and square arrangement over the hexagonal. The bins are strengthened by cross ties. Each octagonal bin is in communication with one of the square bins. The base of each consists of a groined concrete arch, of considerable strength, though the weight of the grain will be mainly supported by the side walls, inasmuch as the grain wedges together, forming an arch on its own account.

Three million bricks were used in this store, which was built nine months ago by the contractor, Mr. Robert Worthington. In the new buildings is to be seen a well designed horizontal compound mill engine, fitted with Collmann's valve gear. It was put down last year to work the elevators in the store, and has behaved pretty well so far. A short ride by the narrow gauge railway down the spiral, passing the malt house, and then down the zigzag, leads to the cooperage and other departments situated on the lower level. All the casks required are made by hand on the premises; and the washing appliances are capable of washing 8,000 casks in a working day of ten hours. The casks are cleansed in the washing machines by means of hot water and chains. At this point Sir James Douglass reminded the bystanders of the fact that the cask-washing machine was invented by a son of the famous Wm. Symmington, who engined the steamboat of Miller, which was tried on Dalswinton Loch in 1788, and constructed the Charlotte Dundas in 1802. The filling of casks is effected by Smith's rackers. The proximity of the lower premises to the railway and river offers great facilities for the dispatch of such heavy products as porter and grains; and advantage has been taken also of the very large supply of water suitable for refrigerating, which is pumped from a well sunk some 40 ft. into the gravel, by engines placed 16 ft. below the ground level. The firm employs about 1,600 laborers besides tradesmen. In addition to the departments referred to above or in Mr. Geoghegan's paper, there are workshops for fitters, plumbers, smiths, carpenters, etc., as well as printing and other offices.—*The Engineer.*

MANUFACTURE OF DAMASCENE GUN BARRELS IN BELGIUM.

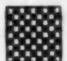
LIKE every other branch of the Liege small arms industry, the manufacture of "damascened" gun barrels is confined to a particular locality; its headquarters are to be found at Nessonvaux, and to a less extent at Trooz, both situate in the charming valley of the Vesdre, through which flows a somewhat murky stream, which is utilized for turning numerous water wheels along its course. The workmen are said to be exceedingly skillful in the necessary manipulations connected with their handicraft, and the work is severe, as a visit to the forges will testify; but here, as elsewhere, the division of labor is economically perfect. Before describing the operations carried on in these rudely constructed workshops, where the results seem out of all proportion to the crude methods employed, it may be as well to give a brief outline of the history of the "Damas" process itself and its several developments down to our own times.

As its name imports, the process originated at Damascus, where it was first employed in the manufacture of cimeters, swords, daggers, knives, and other lethal weapons. Technically, it means the reproduction on the surfaces of the arms indicated (which were always made of the highest quality steel) of certain fine variegated lines, sometimes of a wavy character, at other times crossed, interlaced, and veinous, or parallel. The form of the *damas*, however, was as varied as it was always beautiful. Though Damascus is asserted to have been the birthplace of the industry, there are not wanting those who affirm that the honor really belongs to the far-famed Golconda, where the purest crucible ingots of steel were manufactured, each ingot being of the size of a halfpenny roll, which, when cut in two, formed two swords.

Of the Eastern origin of the industry there can be no question, though its history, unfortunately, is lost in the dimness of far distant ages. Unlike some other handicrafts of the ancients, however, the "damas" process has never been a lost art, but has flourished, in one form or another, from the earliest times. At first employed in the ornamentation of swords and cimeters, it came eventually to be introduced into armor, helmets, shields, etc.; and, finally, to be embodied in firearms, where it has taken a new lease of life. Curiously enough, it has been revived in more than its pristine splendor in Russia, or rather in Siberia, where, aided by the researches and genius of the famous Anosoff, director of the arms manufactory at Zlatoust, steel equal to the best products of Damascus, and superior to any made elsewhere, has been regularly produced. The term "damas," or "damascene," it may be remarked, is applied generally to all steel which exhibits a surface bearing dark or wavy lines. In some kinds of steel this figuring only appears after burnishing; in others, pickling in weak acids will bring it out. Where these lines are not inherent in the material itself as the result of special treatment in the forging, somewhat similar, and even far more elaborate, effects may be produced by subjecting the steel to corrosion. In the latter case, however, it is necessary that the figure sought to be reproduced should have been previously designed upon the material. Various other methods are also employed to beautify and embellish gun barrels, such as inlaying or incrustation, but all external treatment is held to bring the weapon under the

category of *faux damas*, or "false damascening." The true damascened barrel can only be produced in one way, and that by forging, which will be briefly described. What may be termed the literature of this interesting process does not appear to be very extensive, for so eminent an authority as Dr. Percy, the late president of the Iron and Steel Institute, in his *magnum opus*, "The Metallurgy of Iron and Steel," discusses the subject in very few words, and reserves all his admiration for what may be called the "acid process" of damascening, as practiced by a well-known West End gun maker, while he ignores almost entirely the effects produced by the mode in which the iron and steel fillets are forged, and as they subsequently appear in the real Damascus blade or gun barrel. This arises probably from the fact that the "damas" industry has been almost exclusively confined to one or two foreign countries, and, in consequence, perhaps, it escaped the great metallurgist's notice. In the main there are three processes in the manufacture of damascened gun barrels, viz., parallel fillets or ribbons of iron and steel, torsional, and mosaic. The torsional process seems to be the one most in vogue at present, and it is possible, it appears, to vary the patterns almost *ad infinitum* by a particular arrangement of the sizes and forms of the wires and fillets which enter into the damascened rod or *masse*. The accompanying illustrations are exact *fac-similes* of two of these rods, which form the basis of various popular patterns of gun barrels. No. 1 gives a

No. 1.



No. 2.

view of a number of exceedingly thin layers of iron and steel, the dark lines representing the steel, and the lighter ones the iron.

In the second view, the mass, it will be perceived, contains 81 squares, the darker ones being composed of steel and the lighter ones of iron. Out of this is made the well known Bernard "damas," while out of the material represented by No. 1 are forged the numerous varieties of plain striped damascened barrels produced by the Belgian makers, the closeness of the stripes as they appear in the twisted barrel being determined by the distances separating the iron from the steel fillets in the original rod. The common, or sham, damascened barrel is composed of a plain ribbon of iron or steel hammered into the shape of a gun barrel on a mandrel, the stripes or wavy lines which afterward appear on the surface being produced by certain acids, which help to bring out the natural fiber of the material, just as the grain of wood is brought out by polishing. By means of the rods represented in the second engraving, much finer patterns of the "damas" are produced than can be had from either of the foregoing processes.

In nearly every instance, however, the workman engaged in the "compilation" of the materials which enter into these rods has his own special sets of patterns, and none other than these will be attempt to produce. Those who are acquainted with the various patterns have no difficulty in ascertaining the forge from which the barrel has emanated, and, as in other branches of the small arms industry, the secrets of the handicraft are transmitted from father to son. The steel is bought in Germany and in England, the iron coming both from England and Belgium (Lowmoor iron and Bessemer steel are said to be much used, and good scrap, like old horseshoes, is in request for the stub or commoner barrels). The materials of which the *masse* is composed are handed to the barrel maker in the first instance, and by him arranged either as shown in the illustrations or in any other way necessary for the production of the pattern which he desires to produce. Sometimes they are inclosed in a thin casing of sheet iron or merely bound together with wire.

They are then sent to the rolling mills, where they are heated and drawn out by the rollers into long strips or rods about 1½ inch square. These strips are reheated and again drawn out in rods several yards long —according to the requirements of the barrel maker— and are generally from one-fourth to three-eighths of an inch square. The strips thus obtained constitute the "damascus." If the object be a finer quality, or a further variation of the pattern or design, the *baguettes* or "fagots" are again heated red hot, hammered together at the ends, and twisted each in a reverse manner to the other, the object of this counter twisting being to secure a more elaborate but still regular pattern. The threads running through the "fagot," though further mixed and twisted by this treatment, still retain their individuality in the mass.

Among the Liege makers five patterns are said to be in especial request, namely, the "Bernard," "Clou," "Turc," "Boston," and "Crolle." For the "Damas Bernard" (first introduced by Messrs Bernard, Paris) it is necessary to have eighty-one rods (really wires) of iron and steel (see No. 2) superposed one above another in nine different lines. The iron wire is 14 millimeters square, the steel 12 millimeters, but when welded and drawn out, the rod thus formed is only 8¼ millimeters square, and is cut into lengths of 50 centimeters. The "Damas Clou" is made in a somewhat similar manner, except that the number of iron and steel wires entering into the *masse* is only twenty-six instead of eighty-one. In this case the iron wire is 12 centimeters wide by 6 millimeters thick, and the steel 12 by 4 millimeters. The mass is also cut in lengths of 50 centimeters, and drawn out to a thickness of 7¼ millimeters. The "Damas Turc" is nearly similar in character to the "Clou," with the exception that a finer quality both of iron and steel is used, and that the steel wire or thread is 4½ millimeters thick instead of 4. The "Damas Boston" is very similar to the "Damas Clou," but is inferior to the latter. In the "Damas Crolle" sixteen iron and steel wires are employed, the iron being 12 centimeters wide and 10 millimeters thick, and the steel 12 by 7 centimeters. Among the other patterns may be mentioned the "Zebre," the "Mineur," the "Moire," the "Ruban Anglais," the "Ruban d'Acier," etc. As a general rule, the more steel used in the "damas," the better the quality of the pattern.

All the damascened barrels are used for sporting guns; they will therefore be found in double-barreled breech loaders, and to a very much lesser extent in the single-barreled guns, probably not more than three or four per cent. of them being in the latter. There is said to be a somewhat brisk trade going on between these little forges and the rolling mills in which the materials for the "damas" are prepared for the workmen. The cost of these materials (per 100 lb.) is somewhat as follows: Flat bars (steel), 2*l.* 4*s.*; square ditto, 2*l.* 8*s.*; flat bars (iron), 1*l.* 4*s.*; square ditto, 1*l.* 8*s.* The cost of reducing these rods at the rolling mills to the required dimensions is: For steel (per 100 lb.), 4*s.* 5*d.*; iron, 4*s.*; heating and rolling the mass for ribbon strips, 6*s.* 11*d.* to 8*s.*—*Ironmonger.*

THE MANUFACTURE OF GUNPOWDER.

Prepared in part by FREDERIC H. ROBINSON.

THE manufacture of gunpowder consists essentially in mixing the three ingredients, sulphur, saltpeter, and charcoal, in such proportions that, when heat is applied, the whole becomes ignited, generating great heat, which expands the gases formed. The process is most complete when the substances are wholly converted into gases and vapors. The object is to have CO_2, not CO, formed. The latter arises from incomplete combustion. The gases come from the combination of the C of the charcoal with the O of the nitrate of potash. The S facilitates the liberation of the O, combining with the metal, forming sulphuret of potassium.

Walking a few rods from the office of Du Pont's powder mills, Wilmington, Delaware, we entered the wood yard, where were great stacks of willow and poplar, part of which was already barked and stacked to dry. This wood, before being charred, is separated into two grades, the smaller of which contains mere branches, not more than an inch in diameter. For the manufacture of gunpowder the smaller wood is preferred, since it is easily charred, so as not to leave any O behind, this precaution being necessary in the production of good gunpowder; since if any O remains combined with H, so as to form water, such a large amount of heat will be absorbed by the water during the ignition of the powder that very little force will be given to the ball or shot. The coarse wood, mixed with the poplar, gives charcoal for blasting powder; since, though some of it be imperfectly charred, sufficient time is allowed such powder to undergo complete combustion before the expansion of the gases bursts the rock. A coarse-grained wood, as willow, is selected, because it requires but three or four hours to char it, while oak would consume a much longer time. All wood should be thoroughly dried before being charred.

In the coal house near by were five or six cast iron cylindrical vessels containing the wood which was being charred. These retorts are sunk in an iron platform to such a depth that their lids are about five inches above the floor. The retorts are about four feet in diameter. Each one has a copper pipe in the lid for carrying off the pyroligneous acid, etc., formed during the process. The fire is kindled under these vessels. Up to about 150° F. the product of distillation tastes quite like distilled water; as the heat increases it begins to assume the taste of burned wood. The H is not entirely driven off unless the wood is subjected to a very high temperatnre. The presence of H is an advantage in powder used in shotguns, as rapid combustion and the production of a high temperature are required. When the explosion takes place, the heat, produced by the combination of this H with the O of the niter, is very great. Hence the temperature for the charcoal for shotgun powder is raised to only 480° F., and kept at that point for three and a half hours. For cannon or blasting powder it is raised to 600° F.

When the wood is sufficiently charred, it is taken out of the retorts and placed in a room to be sorted. Here it is separated into three classes, one consisting of that which, from being in contact with the sides of the retort, has been too much charred. This class is distinguished by the very black, glossy surface. Another class, which has not been sufficiently charred, is of a light brown color. The third class, which is selected for shotgun powder, is of a reddish brown. It is, however, entirely unfit for rifle powder, since it would produce too rapid combustion.

Next is the saltpeter department. Here the saltpeter in the crude state is separated from its impurities. Common salt and chloride of potassium, on account of their property of absorbing moisture, must, as far as possible, be gotten rid of. In order to do this, about 20 tons of saltpeter are placed in a vat standing about 15 feet high, in which it is subjected to the action of a constant stream of water. In cold water the chlorides dissolve first and escape through a pipe at the bottom of the vat. After several such washings the saltpeter is, to a great extent, freed from the common salt. The vat is shaped like the inverted frustum of a cone, and revolves about an axis. Six or eight feet from the vat is a large tank, so placed that about four feet of it stand above the level of the floor. When the salt has been separated, the contents of the wooden vat are emptied into this copper tank and dissolved in hot water. About two pounds of glue are dissolved in 200 pounds of cold water. This solution also is thrown into the tank. By stirring with a long rod the contents of the tank are thoroughly mixed. The cold solution of glue, chilling the niter, causes it to settle, while the glue rises to the surface, clearing the niter of mechanical impurities. It may be necessary to repeat this operation. If so, a weaker solution of glue must be used, since the niter, being partly crystallized, would have a tendency to adhere to a strong solution. When this operation is completed, the niter is removed from the tank to a long wooden trough and dissolved in hot water. The solution is kept stirred so as to cause the niter to subside in minute crystals, thus avoiding the presence of the mother liquor, which, were large crystals formed, would, by capillary attraction, remain in their seams.

The niter, when deposited, is removed from the mother liquor and placed on a platform to drain. It is then washed to rid it of all the mother liquor. For this purpose it is placed in perforated wooden boxes, and distilled water is poured upon it. This water soaks through the mass and escapes through the bottoms of the boxes. At this point the purification, as far as chemical impurities are concerned, is ended. From the boxes it is removed to the drying mill. It is spread on a circular floor about 20 feet in diameter, and over it passes a large number of rollers. Alternate with these rollers are plows or scrapers which keep the niter stirred. The water is evaporated by heat, communicated to the bottom of the floor. When thoroughly dried, which requires several hours, the niter is passed through fine sieves.

The charcoal and sulphur are ground together. The two substances are placed in barrels in proper proportions. These barrels have horizontal shafts passing through them from end to end, about which they revolve. There are about a dozen of these barrels on one shaft, and in each barrel is a number of malleable iron balls. As the barrels revolve, the balls, falling about, crush the charcoal and sulphur to the proper degree of fineness. The pulverized mixture is passed through a sieve to remove the coarse pieces of charcoal.

From this mill the powdered charcoal and sulphur are taken to the incorporating mill, where they are mixed with the proper proportion of the prepared saltpeter. The mixture, together with a number of zinc balls, is then placed in barrels made of buckskin stretched on frames. These barrels are driven in a manner similar to that in which those used in crushing the charcoal are driven. Since there is a small amount of moisture in the ingredients, it is necessary, while the barrels are revolving, that care should be taken that the powder does not adhere to the sides. If it should, the accumulation of the powder might hold the balls in its mass, forming, as it were, a fly wheel. In order to prevent this accumulation, the sides of the barrel are struck with a wooden mallet. The operation going on in the barrels is for the purpose of producing a homogeneous mixture of the three ingredients.

When thoroughly incorporated, the powder is taken to a building where it is mixed with water—in winter 3½ per cent., in summer 4 per cent.

The powder is then ground. It is so spread over the bed of the mill as to cover it to the depth of two or three inches. There are two large cast iron edge wheels, each weighing eight tons. These, which are driven by an upright shaft, move over the powder, grinding it to a high degree of fineness. There are at one time only about 100 pounds of powder in each of these grinding mills, so that if an explosion should occur in one of them, injury to the neighboring mills would be avoided.

After being ground, the powder is removed to the pressing mill, where it is subjected to a pressure of 2,000 pounds to the square inch. After being pressed it is very hard, and in the form of square cakes about two feet square and one inch thick. These are passed between rollers upon which are cogs of bell metal. This is merely preparatory to the granulating operation, which consists in passing the broken cake through rollers. These rollers are placed at a distance from each other varying according to the size of the grain to be prepared. As the powder passes between them it falls upon a series of sieves. The part which passes through the first sieve falls upon another, which retains the proper sized grains, allowing the rest to pass through. That portion not sufficiently fine is again passed through the rollers. That which is too fine is returned to the mill to be again pressed.

The next operation is the glazing of the grains. The powder is placed in barrels. As the barrels revolve upon horizontal axes, the friction of the grains against each other leaves the powder glazed and ready to be dried. For this purpose it is placed in bags and taken to the drying house. In a room is a framework, upon which the sieves containing the powder to be dried are placed. After remaining here about eleven hours, it is removed to another building, where it is packed, and from which it is shipped to the various markets.

DISCUSSION.

The following summary of results concerning the explosion of powder and the chemical reaction which occurs during the process was presented by Mr. J. W. Redway.

The explosion of powder is nothing more than the ordinary phenomenon of combustion—that is, the combination of carbon with oxygen to form carbon dioxide. The only difference is that in ordinary combustion the oxygen occurs diluted with four times its volume of nitrogen. In the combustion of gunpowder, not only is the oxygen undiluted, but it is chemically compressed to about one three-hundredth part of its normal volume. This is the secret of the dynamics of a gunpowder explosion. This is why a gunpowder explosion develops a force so much greater than one of carbon "dust" or of coal gas.

The average gunpowder consists of about 75 parts of potassium nitrate, 12 of sulphur, and 13 of charcoal. This corresponds nearly to the chemical formula:

$$2\,KNO_3 + S + 3\,C = K_2S + 2\,N + 3\,CO_2.$$

This has long been considered the chemical reaction of the explosion. The real reaction, however, is far more complex.

A number of analyses of the residues of explosion or combustion, made in part by the writer, he having undertaken the investigation of the solids, showed the following average results in round numbers. These analyses closely confirmed the results obtained by Abel and Noble.

SOLIDS.

Potassium carbonate	0·55
do. sulphate	0·15
do. hyposulphite	0·20
do. sulphide	0·07
Ammoniacal and other products	0·03
	1·00

GASEOUS.

Carbon dioxide	0·49
Carbon monoxide	0·09
Nitrogen	0·36
Hydrogen sulphide	0·04
Other products	0·02
	1·00

There is much variation in the composition of the solid residues, even when the powder is ignited in a vacuum, but inasmuch as powder is composed of elements of strong affinities, a slow uniformity of the percentage of products might be expected. The composition of the gaseous products is more uniform than that of the solids.

The volume of the permanent gases reduced to normal tension (one atmosphere) and temperature is from 275 to 290 times the volume of the powder. If the cham-

ber containing the powder is entirely filled, the tension of the liberated gases varies from 31 to 37 tons per square inch, the theoretical pressure being about 42 tons per square inch, with the gases reduced to normal tension and temperature.

But the temperature of the elements at the time of explosion may be safely estimated at 2,200° C., and therefore the volume of the liberated gases will exceed the values already noted, being nearly eight times as great theoretically.

Practically all of these values must be taken with more or less allowance, as all analyses, physical, chemical, and dynamic, demonstrated that inconstancy of result was one of the most noticeable factors.

The explosion of nitro-glycerine is wholly unlike that of gunpowder. The latter is reaction and combination; the former, molecular disintegration.

A molecule of glycerine, a very stable substance, may be represented by the formula $C_3 H_8 O_3$. If, however, we allow a fine stream of glycerine to trickle into a vessel containing red, fuming nitric acid, it undergoes a remarkable change. The atoms of hydrogen are dropped, and in their place the glycerine takes up three molecules of a nitrogen compound having the composition NO_2. The glycerine, in other words, has become nitro-glycerine, and has the formula $C_3 H_5 (NO_2)_3 O_3$, and it is marked by extreme instability. It is like a boiler with a pressure the merest trifle below the bursting point—a slight percussion, and the bands are broken. There is no combination of atoms in the nitro-glycerine explosion. The molecule merely falls to pieces. It does so *instantly*, and nine hundred volumes of gaseous products, chiefly carbon dioxide and nitrogen tetroxide, resume their normal condition. In other words, the gaseous products have nine hundred times the volume of the nitro-glycerine. This, together with the instantaneity of the explosion, may explain why nitro-glycerine is so much more destructive in its effects than black powder.—*Proceedings of the Engineers' Club of Philadelphia.*

HIGH EXPLOSIVES AND HIGH EXPLOSIVE PROJECTILES.

IN the last volume that has been issued by the U. S. Office of Naval Intelligence (General Information Series, No. VII.) is a paper on the above subject by Lieutenant C. E. Vreeland, of the U. S. N.

Melenite, so Lieutenant Vreeland says, is believed to be a mixture of fused picric acid, in granules, with tri-nitro-cellulose dissolved in ether. It was originally invented by M. Turpin; but the French government is declared to have so much improved upon M. Turpin's compound that the inventor would scarcely recognize the substance that is now used in France. The original secret is purchasable by any government that may choose to buy it, and it is reported to have been already acquired by the Elswick Ordnance Company. According to "Le Manuel du Dynamiteur," by M. Max Dumas-Guilin, the explosive force of melenite is only three times that of gunpowder. Less authoritative statements set it down as from five to seven times that of gunpowder, but the recent French experiments with the old iron-clad Belliqueuse seem to conclusively establish the approximate correctness of M. Dumas-Guilin's estimate. The effect of a shell charged with melenite striking against the armored part of the ship was inconsiderable. On the other hand, shells that struck the unprotected parts are said to have caused terrible havoc. These results, so far as is known, agree with the results which have been obtained at Portsmouth during the experiments on her Majesty's ship Resistance. Many French naval experts are now, in consequence, advocating a reversion to the old system of giving a battle ship something like complete armor; and it is now no secret that the construction of the battle ship Brennus and the cruiser Dupuy de Lome has been modified in accordance with their views. The French have succeeded in safely firing melenite shells from guns that give a muzzle velocity as high as 2,000 ft. per second, and shells containing 70 lb. of melenite have repeatedly and without accident been thrown from an 8·6 in. mortar with a muzzle velocity of over 1,300 ft. per second.

Roburite, the new German high explosive, belongs, says Mr. Vreeland, to what is known as the Sprengel class—that is, to the class of explosive mixtures of two substances, neither of which by itself possesses explosive qualities. In the case of roburite both these compounds are solids, and the resulting mixture has a sandy, granular appearance somewhat resembling common yellow sugar. It has been experimented with at Chatham under the direction of Major Sale, R.E., and these experiments have substantiated some, at least, of the claims which its inventor, Dr. Carl Roth, makes on behalf of it. He claims (1) that the two components are perfectly harmless and inert separately; (2) that even when mixed or ground together in an ordinary coffee, cement, or flour mill, the mixture cannot be exploded by friction, percussion, or the application of flame; (3) that, when detonated, roburite produces neither spark nor flame; (4) that it produces very little noxious gas; and (5) that it is not subject to deterioration through climatic variations of temperature. It should be kept dry, but even if it become damp its strength can be safely and perfectly restored by the application of heat. Experiment proves that it is stronger than any known picric powder, that in some respects it is more powerful than dynamite, and that, owing to the safety with which it may be handled, it is eminently fitted for use as a bursting charge for shells. But it does not seem to be as yet established that it is adapted for submarine mining. A roburite factory has been founded under government sanction in Germany, and the establishment is at present capable of turning out about two tons a day.

Bellite, a new Swedish high explosive, owes its discovery to Mr. Carl Lamm, managing director of the Rotebro Explosives Manufactory, near Stockholm. It is stated to consist of ammonium nitrate and di-nitro-benzol, which, when melted together at a temperature of from 176° to 194° Fahr., are mixed with saltpeter, and form a compound of which each molecule is explosive. It is in a granulated state that it appears to be best adapted for military purposes. It then has a specific gravity of from 1·2 to 1·4, and may be fully exploded by the aid of a small quantity of fulminating mercury, even if it be confined only by the pressure of a thin sheet of tin. When pressed into hard cakes, it needs a stronger impulse and stronger confinement; and the covering, whatever it may be, must, moreover, adhere to the cake. Heated gradually in an open vessel, bellite begins to evaporate at a temperature of 302° Fahr., and the rapidity of evaporation increases as the temperature rises, but no explosion occurs. Heated suddenly, bellite burns with a sooty flame; but, if the source of heat be removed, combustion ceases, and the substance assumes a caramel-like structure, the composition remaining as before, save that the proportion of saltpeter is somewhat reduced. Bellite can withstand blows, fire, friction, and vibration without being exposed to the slightest risk of explosion, and it may be stored without danger of spontaneous combustion. Exploded in a submarine mine, it gives, at a distance of 17 ft., a blow 10·4 per cent. greater in force than is given by gun cotton under similar conditions. At a distance of 12 ft. 6 in. the superiority of bellite increases to 15·2 per cent. This seems to specially fit it for use not only in mines, but also in torpedoes.

Carbo-dynamite is a recent British invention which owes its origin to Messrs. W. D. Borland and W. F. Reid. The base is nitro-glycerine and the absorbent is carbon. It is as cheap as ordinary dynamite, but it is alleged to possess several advantages over it. For example, it has much greater explosive force, seeing that 90 per cent. of the compound is pure nitro-glycerine, and that the absorbent itself is highly combustible. In addition, it is claimed that, when the dynamite is wet, no exudation of nitro-glycerine takes place from the absorbent. It is even declared that some carbo-dynamite which had lain for eight months in water presented at the end of that period the same appearance as when first immersed, and had suffered no deterioration of its explosive qualities.

Graydonite is the invention of Lieutenant James Weir Graydon, late of the U. S. N., who in 1886–87 conducted, first in California and afterward in Russia, a series of experiments with the Graydon dynamite shell. This he succeeded in firing, with some degree of success, from a 6 in. rifled gun that was loaded with a mixture of 11 lb. of dynamite to 37 lb. of powder. Mr. Graydon claims for graydonite absolute freedom from danger in handling and transportation, a destructive power from 400 to 700 per cent. greater than that of No. 1 dynamite, and suitability for military and naval uses. Particulars of its composition have not been made public. Since the conclusion of the experiments in Russia, the Ordnance Board of the United States Army has assisted at further experiments with the Graydon dynamite shell at Sandy Hook. The Graydon method of charging the shell consists in subdividing the bursting charge of dynamite into small pellets, each of which is inclosed in a separate envelope and treated with paraffin. The interior of the shell is previously lined with asbestos. Explosion is secured by means of a detonator, which acts upon impact. The great advantage of the shell is alleged to be that it can be fired from any service gun with the ordinary service charge of powder. At the Sandy Hook experiments a 7 in. Ames wrought iron muzzle-loading rifled gun was used, with a powder charge of 23 lb., and with a steel service shell that weighed, with its charge of 2·3 lb. of No. 2 dynamite, about 122 lb. The target was a section of wrought iron turret, made up of two 7 in. plates, so as to give a total thickness of 14 in. The target was, however, not a new one. It had been indented by previous practice, and several cracks in its surface were noticeable. Three shells were fired at, and burst on, the surface of this target. The third round penetrated the first plate, seriously bulged and cracked the second, and had a generally disruptive effect upon the turret. Next day four rounds were fired, two at a wooden target a mile away, and two seaward. All the shells were fused. The first shell burst prematurely 300 yards from the gun, the second burst at or beyond the object, the third did not burst, the fourth burst prematurely at 1,000 yards. These results were not satisfactory. Later in the day the liability or otherwise of the dynamite to explode on being fired into with small arm projectiles was tested. This experiment was also unsatisfactory. The compound exploded on being struck at 50 yards by a Springfield rifle bullet. Yet it was something to have shown that the dynamite shells could be successfully fired from an ordinary gun, and were capable of inflicting serious damage upon a somewhat heavily armored target.

The Smolianinoff explosive has also been experimented with in America during the past twelve months. The composition consists of 80 per cent. of nitro-glycerine combined with a certain fluid, the nature of which is a secret. The target was similar to that which was used in the Sandy Hook Graydon experiments. A 100 pounder Parrott gun was employed, and three shells were fired, the first two weighing 69 lb., carrying 4·6 lb. of Smolianinoff explosive, and the third weighing 82 lb., and having a 4·1 lb. bursting charge. The firing charge in each case was 18 lb. of Du Pont powder, the range was 101 yards, and the muzzle velocity was about 1,490 ft. The first shell was not fused. It struck the target and broke up with a low explosion, doing only superficial damage. The second shell was fitted with a detonating percussion fuse. It struck the target, exploded with much more force than had been developed by the unfused shell, did some surface damage, and badly injured the target's foundations. The third shell produced much the same results. No damage was done to the gun, and the weakness of the cast iron shells which were used, as well as the shape of the heads, which were suitable only for a nose fuse, was held to be mainly responsible for the unsatisfactory nature of the experiments. These, we hear from other sources, are to be repeated under more favorable conditions.

The Snyder explosive has recently been tested, with very successful results, in Turkey. It consists of 94 per cent. of nitro-glycerine and 6 per cent. of a compound of collodion, gun cotton, camphor, and ether; and it is exploded by mere percussion against any hard body. It is, nevertheless, said to be safe to handle. The gun employed was a 6 in. rifled piece. The target, 220 yards away, was composed of twelve 1 in. steel plates, welded together and backed with 12 in. and 14 in. oaken beams. It measured 14½ ft. by 4½ ft., and weighed more than 20 tons. The charge of Snyder explosive was 10 lb. The target was utterly destroyed at the first shot, and nine other shots were fired without accident of any kind. This explosive, which is the invention of Mr. F. H. A. Snyder, of New York, appears to have an important future.

Gun cotton shells have, since 1885, been extensively experimented with in Germany. In 1883 Herren Von Forster and Wolff, of the Walsrode gun cotton factory, in Hanover, took out two patents—one for a process of preserving gun cotton, the other for the construction of a shell to be charged with that explosive. Preservation is attained by steeping either wet or dry gun cotton in ether or nitro-benzol for from 15 to 20 seconds. This causes a hard, impervious film to form on the surface of the cotton. The film does not interfere with the explosive properties; but it prevents decomposition and loss of consistency and humidity. The shell was never tried; but in 1885 a new patent was taken out for a system of filling which could be applied to shell of service pattern. Wet gun cotton compressed disks are cut up into prismatic grains, and to these are added about 200 grammes per charge of dry gun cotton. Space being reserved for the fuse and detonator, melted paraffin is poured over the charge, which is protected by the preservative film, and the whole, as it cools, forms a solid mass. The fuse is similar to the German service percussion fuse of 1873. The fulminate capsule is immediately surrounded by ten grammes of dry gun cotton, and is protected from shock by India-rubber rings. The shells are stored filled, but not fused. Early experiments were not satisfactory, and certain changes were made, especially in the arrangement of the capsule. Since then more than 200 shells have been fired without accident, and with complete explosion, from the 3·4 in. gun; and 35 lb. charges have also been fired from the 5·8 in. gun and 100 lb. charges from the 10·9 in. mortar, with equally satisfactory results. Quite recently Mr. Von Forster has further improved his fuse, and experiments have been continued with an 8·1 inch Krupp gun, a 48 lb. charge of powder, and a projectile weighing 220 lb., and filled with 2 lb. 3 oz. of gun cotton. The initial velocity was about 1,410 ft. per second. The target was a compound 4·6 in. plate, measuring about 39 in. by 78 in., backed by 20 in. of oak. Four yards in rear of the target was a palisade of pine stocks supporting an earthen wall over three yards thick. The shell perforated the plate, backing, and palisade, and burst only after entering the wall of earth. The performance was, therefore, very satisfactory, for the weak point in many high explosive shells is that they have a tendency to burst too soon after impact.

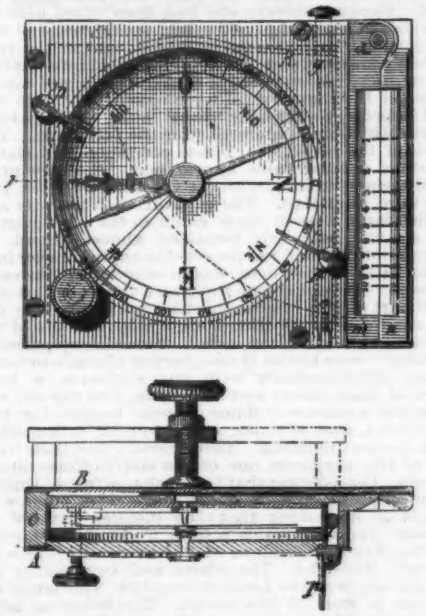
The general effect of the dynamite shells which were fired toward the end of last year from the Zalinski pneumatic gun at Fort Lafayette, in New York harbor, was made public at the time. The details did not appear. They are now given at length. The shells used were each charged with 50 lb. of blasting gelatine and 5 lb. of No. 1 dynamite, and their gross weights varied from 136 lb. to 137 lb. The target was the old government schooner Silliman, which was moored with her stern toward the firing point, and distant 1,864 yards therefrom. The schooner was 79 ft. long and 22 ft. in breadth, and had a depth of 8 ft. 6 in. A trial sand-loaded projectile was first fired in order to get the range. It struck 24 yards to the right and 27 yards short of the vessel. The second shot entered the water 8 yards to the left and 10 yards short, but for some unexplained reason did not explode. The third struck a little astern and on the starboard quarter of the schooner, and exploded under water, breaking off the mainmast just above deck, throwing down bulkheads, breaching the planking under the quarter, and letting about 2 ft. of water into the vessel. The fourth shot struck the water close to and abreast of the starboard quarter, and must have exploded very nearly under the schooner's center. The underwater fuse acted perfectly. The vessel's back was broken, and she fell back a complete wreck. On this occasion the high trajectory of the gun was much objected to by the experts who were present. The projectiles fell into the water at as great an angle as 18 deg. or 19 deg. On the other hand, the high trajectory prevented ricochet, and insured a proper entry into the water for torpedo action. The United States Navy Pneumatic Dynamite Gun Board subsequently witnessed experiments to test the rapidity of fire, accuracy, and extreme range of Lieutenant Zalinski's weapon. The board reported (1) that the dynamite gun is a new instrument which has its own functions in time of war; that it cannot replace any existing weapon; and that its place cannot be wholly taken by any other; (2) that the value of compressed air as a means of throwing projectiles from a gun is chiefly apparent in the ability which it gives to the gunner of exactly reproducing any shot, and of accurately increasing or decreasing range at will; (3) that the machinery employed in connection with the control of air under great pressure is very effective; (4) that the gun is remarkably accurate; (5) that the extreme range is probably about two miles, the effective range from 1,400 to 1,800 yards; (6) that the power of the projectile has not yet been thoroughly tested; (7) that the gun appears to be trustworthy in its action; (8) that the system is a simple and not expensive one, and that the gun might be made in any large town where there are foundries and machine shops; (9) that the weapon is valuable for harbor defense; (10) that it is adapted to naval warfare whenever mortar fire can be advantageously used; (11) that a modification of it might be adapted to the projection of torpedoes from ships; (12) that, until after the gun has been properly tested on board the dynamite cruiser which is now under construction, it will be inexpedient to adopt it as part of the battery of ships of war. The dynamite cruiser, it may be mentioned in passing, was built by Messrs. Cramp, of Philadelphia, but is not yet ready for sea. Instead of the 10·5 in. pneumatic guns for which she was originally designed, she is to have three 15 in. tubes, which will be able to throw up to 600 lb. of explosive gelatine. The length of her guns, which was excessive, has also been shortened to 55 ft. In the meantime a Zalinski gun, with a caliber of 15 in. and a length of only 40 ft., has been constructed for the Italian government.

Another pneumatic gun has, according to the *Temps*, been tried this year in Germany, under the supervision of the German Admiralty. The instrument is of 11·7 in. caliber, and is 73·8 ft. long. The shell was 81·5 in. long, and contained 66 lb. of nitro-glycerine. The target was a wooden vessel moored 2,080 yards away from the firing point. Two rounds of shell completely destroyed the craft. Of Mr. Hiram Maxim's dynamite gun little of a practical nature is yet known. It is a pneumatic tube; but the tube is comparatively short, and, according to the specification of the patent, a very high muzzle velocity is attained. The peculiarity of

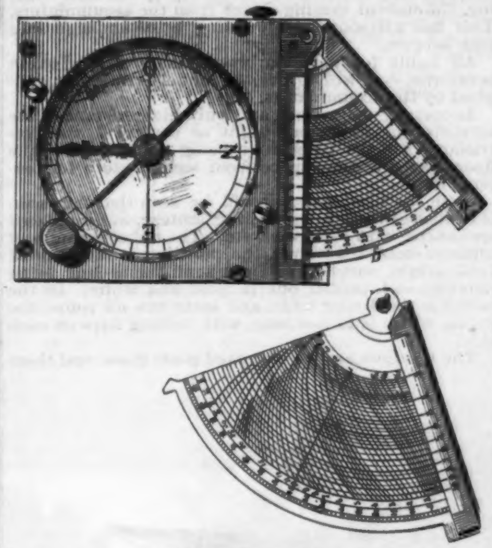
the invention seems to consist chiefly in the substitution of a mixture of air and some volatile hydrocarbon for air alone. This mixture is so regulated that there shall be just sufficient oxygen to convert the hydrogen of the hydrocarbon into water, and the carbon into carbonic acid gas. After the projectile has been driven by the expansive force of the gas through a certain portion of the length of the bore, the mixture of air and hydrocarbon is caused to explode, and the pressure is thereby at once increased about eightfold. The explosive charge in the shell is to be some form of dynamite, detonated by means of a capsule and firing pin. It does not, however, appear that Mr. Maxim has yet built a gun in accordance with his designs. Indeed, if, as the experiments with the Graydon and more particularly with the Snyder high explosive projectiles seem to prove, explosives of the most formidable nature can safely be fired in shells from ordinary service guns charged with gunpowder, it is scarcely likely that pneumatic tubes will henceforth be much in request for a similar purpose. Guns that can be loaded with powder must always be more readily available than instruments which require to be charged either with compressed air or with air and something else. Moreover, heavy guns are much less liable to destruction by an enemy than are the comparatively large and fragile tubes which are at present used by Lieutenant Zalinski. Guns, too, give superior velocities and flatter trajectories; they can be used with equal facility on shipboard and on land; and they possess the great advantage of being already in the hands of both the land and the sea services of all countries.

VERDOT'S ALTIMETER.

PLANE surveying, for which few instruments are required, permits of making a planimetric sketch of a piece of ground in a short time, with a certain accuracy dependent upon the skill of the operator. In such operations, it is often difficult to indicate the disturbances of the ground, and the edifices of which it would be of interest to know the altitude, and the operator contents himself with indicating the changes of level by curves of more or less accuracy. Mr. Verdot's altimeter is an instrument designed for obtaining such data. It is not a surveying, but a topographical instrument. It consists of an ordinary compass, upon which is mounted a sector, S, movable around its center, and upon which is traced a scale giving in units and subdivisions the height of the rectangular triangles whose base is known, and the angle opposite the height. The figures on the small rule, *m a*, of the sector, as well as on the one opposite (*n a*) corresponding to the concentric lines, indicate the units of the bases. Upon the circumference are traced the degrees. The figures placed after, at which end the curves running from left to right indicate the units of the heights.



FIGS. 1 AND 2.—PLAN AND SECTION OF VERDOT'S ALTIMETER.



FIGS. 3 AND 4.—THE VERDOT ALTIMETER.

With this instrument one operates:

From 1 to 10 meters, taking the meter as a unit.

From 10 to 100 meters, taking the decameter as a unit.

From 100 to 1,000 meters, taking the hectometer as a unit.

From 1,000 to 10,000 meters, taking the kilometer as a unit.

And this, too, on the bases as well as upon the heights. The sector is capable of moving around its axis *a*; it is held upon its circumference by a friction stop controlled by a button, *k*. When the face of the apparatus is placed vertically, and the button is pressed, the sector becomes free, and its center of gravity falls upon the vertical passing through its geometrical center, which, at the same time, is the point of suspension.

Upon the face of the apparatus are placed sight vanes, P. These are so arranged that when the top of the apparatus is horizontal, they form with this horizontal the same angle that the free sector makes upon the vertical. If the sight vanes are placed horizontally, as the sector is free, its rule touches that of the apparatus; and if the instrument revolves around its center, the sector will open by the same angle as that of the line of the vanes with the horizontal.

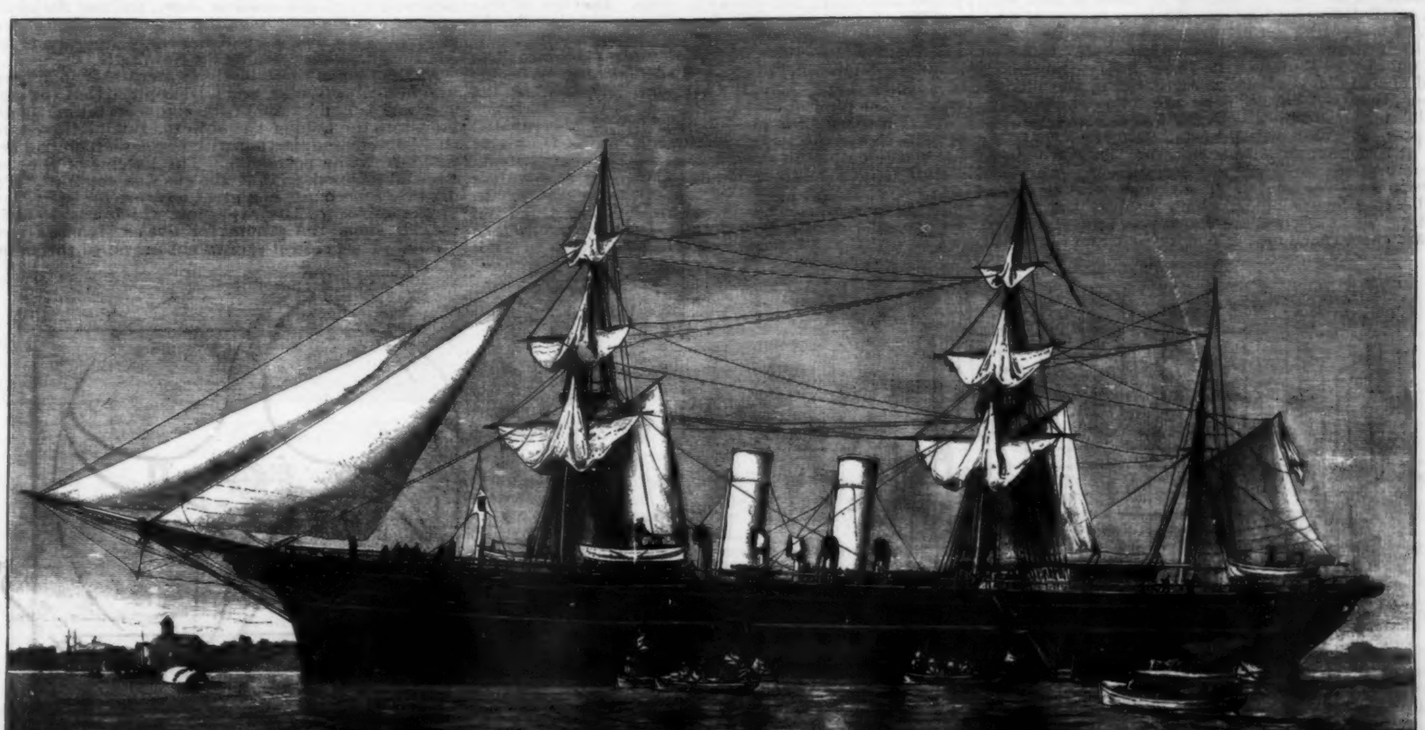
Knowing the base of a rectangular triangle, and the angle opposite the height, it suffices to open the sector to such angle, to follow with the eye, as far as to the fixed rule, the curved line indicated by the number of units contained in the base, and finally to observe the line of the heights, coinciding at this point, and follow it to the left. The figure placed at its extremity will indicate the number of units contained in the height of the triangle. For example, let us suppose a base of 60 meters (6 decameters), the angle opposite being 40°. If we take the curve corresponding to the figure 6 of the division of the bases, we see that it corresponds to the figure 5 of the curve of the bases (point of intersection), whence we conclude that 5 decameters is the height sought.

It is easy to interpolate the differences between the two figures which include the intersection, and to reach quite approximate results.—*Le Genie Civil.*

PORTABLE SAW FOR TREES.

THE saw illustrated herewith is formed of hardened steel plates, which are riveted together in double series for the entire length. The rivets are sufficiently loose to form joints. Each plate or link is shaped on one side to form a pair of saw teeth, one tooth cutting in one direction and one in the other. The plates are a little thicker on the cutting edge than at the back, so that the saw, as it is sharpened, is always set so as to clear its cut. A cross handle at each end of the saw fits into a ring for use. The handles are withdrawn from their rings to render the saw portable. As this saw

can be made entirely of pressed work, it could be made very cheaply. A saw of this kind is equal to a six foot cross-cut saw, weighs only 1¾ lb., and is packed in a leather case, which has a strap to sling over the shoulder, or may be attached to the waist belt, and measures over all 1¾ in. by 3½ in. by 8 in. The saw



THE RUSSIAN IMPERIAL YACHT POLAR STAR.

was found by experiment to cut down a living tree 12 in. in diameter in five minutes. It is thought that it might be useful as a part of military equipment for sappers, and for emigrants, as also for cutting down inaccessible trees, which it does readily, by attaching ropes to it in place of handles. Mr. W. F. Stanley, of South Norwood, is the patentee.—*English Mechanic.*

THE ELECTRIC LAUNCH VISCOUNTESS BURY.

THE Viscountess Bury was launched from the builder's yard, Strand on-the-Green, Chiswick, October 8. This is the largest electrical boat which has yet been seen on the Thames, or probably in the world, if we except that of Mr. Elieson. She is intended for public use, and will carry upward of eighty passengers comfortably.

The Viscountess Bury has been specially designed and built for a private company by Mr. W. Sargeant, electrical launch architect and constructor, Chiswick, Middlesex. She is 65½ feet long, with 10 feet beam, and has a mean draught of 22 inches with a displacement of 12½ tons. The hull is constructed of three skins, the inner being diagonal, and outside planking of bright mahogany in narrow widths. The keel, which runs from stem to taffrail, is in one length, of American rock elm. Deadwood aft has been in this instance entirely abandoned, the object being to assist the steering in narrow bends up the River Thames, and for giving a clear run, and to get greater efficiency from the twin three-bladed propellers, which are built up of steel to a 12 inch pitch and 2 feet 3 inches diameter, rotating outward, and calculated to revolve at 600 revolutions per minute. These propellers are beautifully made, and were provided by Messrs. Thornycroft & Co., the well known torpedo boat builders of Chiswick.

Mr. Sargeant has designed a rudder on an entirely new principle, with the object of clearing weeds, obviating stern-post deadwood and gudgeons, with facilities for quick removal and easy steering. This rudder will be built up of thin steel, galvanized, and slung in a gun metal trunk. The steering wheel is situated right forward on the deck, as shown in the illustration, so that the man operating has full view of all small craft, which so numerously frequent the higher reaches of the Thames in summer. Adjoining the steering wheel will be an indicator communicating with the electrician in charge of the switches controlling the electrical power.

The electrical energy is stored in 200 Electrical Power Storage Company's accumulators of the "1888" type, each of which has a capacity of 145 ampere hours with a discharge of 1 to 50. The midship section of the vessel being perfectly flat, there will not be any lids to these boxes, so in the event of her taking the ground the acid will not slop over. These storage cells are arranged, one hundred on each side of the vessel, under the seats. The space occupied by them is lined with lead, small drains leading into receivers in case of accident, thus securing perfect dryness for the boxes. The cells are computed to hold electrical energy sufficient with one charge to propel the vessel for ten hours at a speed of six miles per hour, as regulated by the Thames Conservancy by-laws. There are two 7 inch "Immisch" motors, which convert the electrical energy into power. These are calculated to develop 7½ brake h. p. at 1,000 revolutions per minute. They are placed under the floor aft, each working direct on to one of the twin propeller shafts. The thrust is taken from a ball-bearing thrust block, which reduces the friction greatly. The switches are fixed, port and starboard, and are two to each motor, one for half and full speed, the other for going ahead or astern. They are worked by the electrician in answer to bell signals from the man at the wheel. Each propeller can thus be worked independently of its twin companion, and so greatly assist the steering in sharp bends of the river.

In place of the objectionable whistle of the steamers a large and melodious ship's bell is placed on the cabin top, and may be sounded electrically by the man steering, the current coming direct from the accumulators. This bell will sound for warning boats and signaling lock keepers.

All lights for port, starboard, masthead, and cabin lavatories, etc., will be incandescent electric lamps, supplied by the accumulators.

Ammeters, voltmeters, and suitable resistances are all under the immediate sight or control of the electrician. All the machinery being placed below the floor, leaves a clear space from stem to stern for passengers.

From the illustration it will be seen that the cabin is furnished with a ventilating lantern, and is placed amidships, with lavatories, etc. The upholstering is of crimson embossed velvet, the paneling is of moulded teak, bright varnished throughout, the ceiling being moulded and picked out in gold and white. In the center is the dining table, and seats run all round the cabin, which is 10 feet long, with folding flaps on each side.

The windows are of engraved plate glass, and those of the ventilators amber in color. The fore and aft parts of the vessel are of bright teak, and upholstered with portable seats, so that the accumulators may be easily examined in case of necessity, or at the time of charging.

The carving on the bow boards and figure head, which represents the Viscountess Bury, was done in an artistic manner by Mr. David Gibb, of Limehouse.

Mr. Sargeant designed another electrical launch, the Malden, which during the past summer was a familiar object of interest on the Thames, especially during the Henley regatta. The Malden is 30½ feet long, with 4 feet 10 inches beam. She was constructed chiefly for experimental purposes, and upon her trials data of great interest have been obtained. On one occasion, with a single charge, the Malden was propelled 56 miles down stream at about 10 miles per hour.

This boat was built by Maynards, of Chiswick, under the superintendence of the designer. The propeller is double bladed, 2 feet diameter, by Thornycroft & Co.

The motor is a 6 inch "Immisch" machine, driving the propeller at 550 revolutions per minute, from 48 accumulators.—*Electrical Review.*

NEW ELECTRIC LAUNCH.

BOTTING'S SNOW DISPERSER.

THE approach of winter should remind vestries and local boards to put their houses in order especially with reference to the contingency of having to meet one of those heavy snowfalls which have more than once surprised and paralyzed the metropolis. In view of this we illustrate a snow disperser, invented by Mr. F. Botting. Fig. 1 of our engravings represents a front, and Fig. 2 side sectional elevation of the machine. The snow is accumulated in front of the machine by means of a snow plow, and the machine following in the wake of the plow does the rest.

The bottom of the machine consists of a corrugated trough, C, with projecting hollow ribs or gills, D. Above are revolving hollow arms, F, on a hollow shaft. Steam is admitted to the trough and the arms by stop valves to heat and keep them at a high temperature. In moving forward, snow is forced up the front scoop, on to the gills of the trough, and becomes reduced to water, and if at all massed in lumps is broken to small pieces by the revolving arms, which carry down the snow into the water in the trough, and, being heated, melt any remaining pieces. The machine may be pushed along in front of a traction engine or road roller, or be drawn by horses, and a separate boiler provided for steam when required to disperse snow without having to cart it to the machine. This, of course, is of great advantage in main thoroughfares. The front scoop plate cannot be lowered sufficiently low to touch the road, and even if it did, it would not clear the numberless holes, but what is left after the machine has passed is to be melted by the hot water that flows from the machine.

Mr. Botting also suggests that the machine may be stationary, and worked by an ordinary traction engine or road roller; these being of little other use in winter, can with profit be used; in cases where more convenient, a boiler and engine will suffice to supply steam heat and power. Mr. Botting last winter showed a working model, one-eighth the full size, to one or two vestries, under steam; the result of its action was that snow and ice was instantly converted into water.—*Iron.*

EXPLOSION OF A PETROLEUM STEAMER AT CALAIS, FRANCE.

ON October 16, a few minutes after nine o'clock in the evening, the usually quiet seaport of Calais was startled by a tremendous explosion. The inhabitants were terribly startled, the shock to the houses being terrific, and many people took to the streets, believing that an earthquake had occurred, windows being broken in all directions, and the gas being suddenly extinguished. It was soon ascertained that the explosion had taken place on board the Ville de Calais, a new vessel of some thousand tons register, which had been built for carrying petroleum between Calais and New York, from which place she had lately arrived. For this purpose she had been fitted with various tanks and tubes. She had completed the discharge of her cargo the previous day, and at the time of the explosion water was being pumped into her ballast tanks. It is supposed that the disaster was caused by one of the engineers taking a naked light into the hold in order to examine these tanks, thus igniting the gas which had generated from the petroleum. The wreck of the vessel, the *Times* correspondent states, presented a remarkable appearance. The crew numbered twenty-six hands, but at the time only ten persons were on board. The captain, with his wife and another lady, were in their cabin in the after part of the steamer, and this remained almost intact, as though nothing had happened—the captain never imagining that the accident was so serious until he came on deck. The rest of the ship, with the exception of a small part of the forecastle, was blown into the air, and scattered in all directions, while the sides of the vessel were blown clean away. Some heavy pieces of machinery were hurled three-quarters of a mile or more. Almost simultaneously with the explosion, a huge cloud of black smoke and debris rose into the air, and burst into a column of flame of great height—the hull becoming a mass of flame, which was not extinguished until the next morning. Three persons lost their lives, one of the engineers, one of the ship's officers, and a seaman. Considering that the dock was full of timber-laden shipping, and that the quays were laden with logs, it is marvelous that the disaster was not far greater. Our illustration is from a sketch forwarded by Mr. Frank Merridew, of the British and Foreign Library, Boulogne. The above and our smaller engraving are from the London *Graphic.* Our larger engraving is from *L'Illustracion.* The following additional particulars are from the London *Fireman:*

A singular explosion took place at Calais on the evening of Tuesday, Oct. 16. The Ville de Calais was a new vessel, and was 1,221 tons register. She was engaged specially in the petroleum trade between Calais and New York, and she was specially fitted with tanks and tubes for carrying the oil. The vessel lay at the end of the dock, scarcely 100 yards from the petroleum reservoir which is erected on shore, and had the appearance of a gasometer. On the day of the explosion she completed the discharge of her cargo, and was to have left the following morning for Newcastle.

At the time of the explosion water was being pumped into her ballast tanks, and it is supposed that the explosion was caused by one of the engineers taking a naked light into the hold of the ship to examine these tanks, the light communicating with the gas which had generated from the petroleum. The hatches of the vessel were all inclosed, so that the gas was confined. This, doubtless, accounts in a great measure for the violence of the report of the explosion, which was so terrific that it shook the ground for five or six miles round Calais. The greatest excitement prevailed throughout

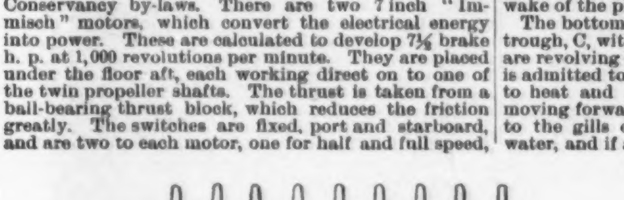


FIG. 1.

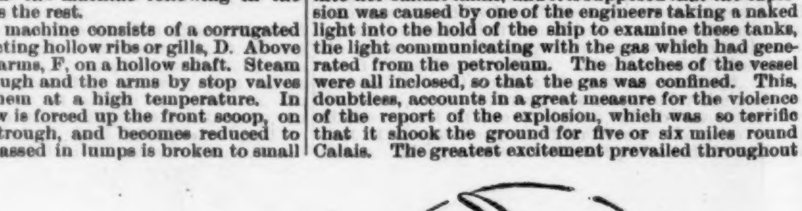
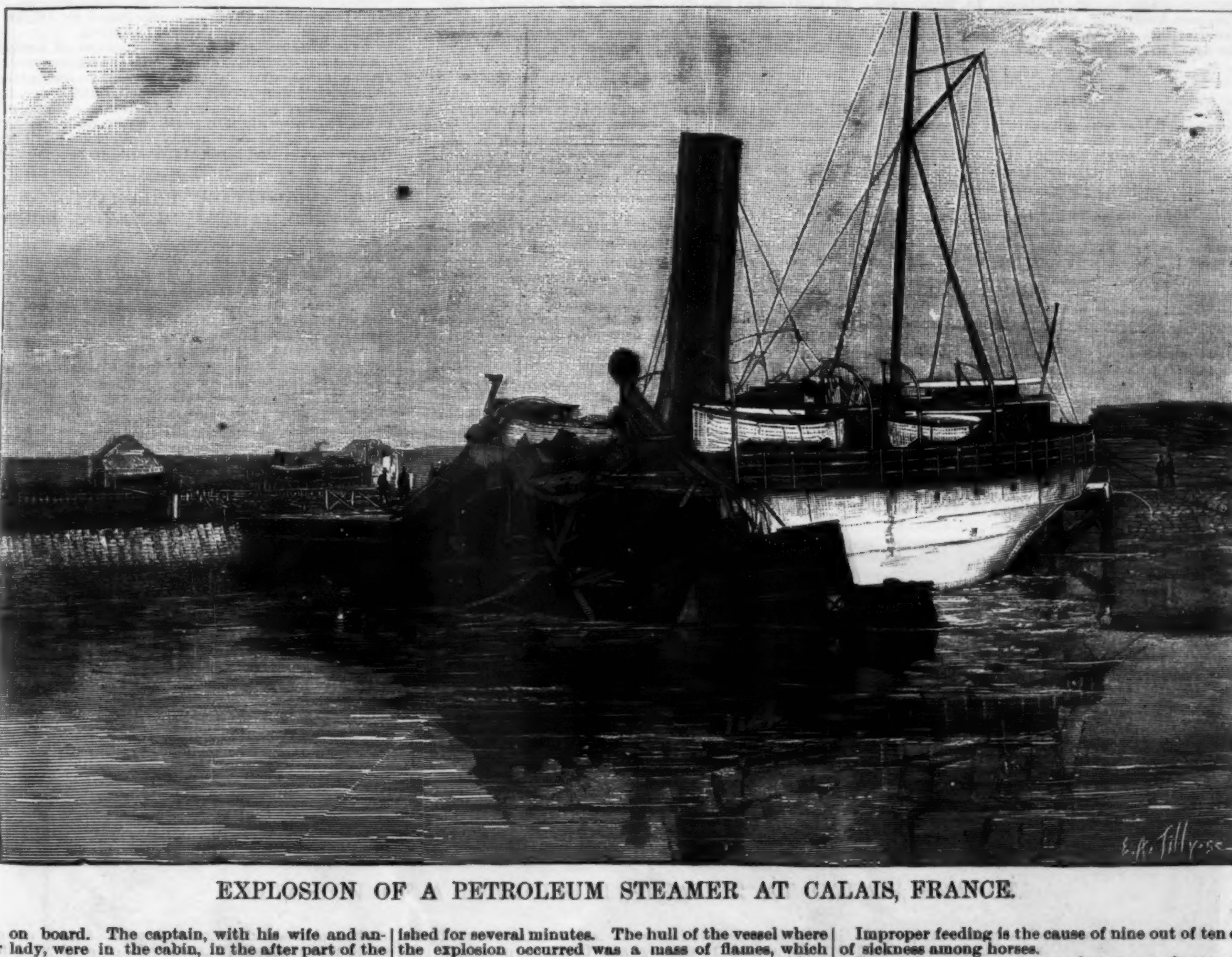


FIG. 3.

BOTTING'S SNOW DISPERSER.

the night. People, believing that an earthquake had occurred, left their houses in terror, and made their way toward the docks, where many thousand people assembled. The streets for several hours were in a state of panic. Bugles were sounded, and the soldiers and pompiers turned out, the former marching down to the quays with fixed bayonets to keep back the crowds.

The effects of the explosion were visible, more or less, in every part of the town. Windows were smashed in all directions, and in some cases large plate glass windows were shaken out of their frames. The railway trains, which were standing in the station and on the sidings, presented a very strange appearance. There was very soon a stampede of people toward the scene of the disaster, attracted by the flames, which lit up the country for miles round.



EXPLOSION OF A PETROLEUM STEAMER AT CALAIS, FRANCE.

At the time of the explosion, only about ten persons were on board. The captain, with his wife and another lady, were in the cabin, in the after part of the steamer, which remained almost intact in a very remarkable manner. The captain stated that he did not imagine anything so serious had happened; but, when they went on deck, the ladies fainted at the terrible sight presented to them. The rest of the ship, with the exception of a small part of the forecastle, was blown into the air, and scattered in all directions. The sides of the vessel were blown clean away. With only a few feet of water in the harbor, all that could be seen of the vessel was the stern to the extent of about one-fourth the length of the ship. From this point nothing could be seen except the bow, a few feet of which stood up. The force of the explosion was so great that the hull of the vessel was shattered, and huge pieces of machinery were hoisted up in an extraordinary manner, large pieces being blown to almost incredible distances. The iron plates appeared in some cases to have been torn into fragments, and were strewn about the quays.

Some pieces of machinery, weighing many tons, were hurled a thousand yards or more. A soldier who was walking about a mile from the dock had a remarkable escape, a large piece of iron falling so near him that it so injured his leg that he was taken to a hospital. The gas in the streets and houses was extinguished by the shock. In some cases, where houses were half a mile from the dock, the shock was so great that people were thrown down in their rooms; the windows fell in, and the curtains stood out two or three feet from the windows, as if by a rush of air, although the night was perfectly calm. A tug and another steamer lying on the other side of the dock were struck with pieces of the iron plates.

Almost simultaneously with the explosion a huge cloud of black smoke and *debris* ascended into the air and burst into a straight column of flame of enormous height, the length of which was not perceptibly diminished for several minutes. The hull of the vessel where the explosion occurred was a mass of flames, which licked out on to the water, and were not extinguished until early the following morning.

Fragments of what was supposed to be three persons—the fire engineer, one of the ship's officers, and a seaman—were recovered and removed to the morgue.

Explosions of this kind are fortunately very rare; they do not occur unless the vapor of the oil is mixed with a large volume of atmospheric air before ignition. Without this addition the gas would be inflammable, but not explosive.

A somewhat similar explosion occurred on the Thames near the Purfleet powder magazines, when the Maria Lee blew up in June, 1873. Vapor from petroleum diffused itself through the air until an explosive mixture was formed, which extended to the cabin in the after part of the vessel. When the captain entered this cabin early in the morning with a light there was an explosion, and flame was at once observed to issue from the other side of the ship. It is somewhat difficult to prevent vapor from petroleum forming and accumulating. It arises even in the absence of direct leakage from barrels. Evaporation and diffusion will occur through the wood itself, owing to the extremely volatile nature of the oil; this occurs especially in a high temperature. It is on record that at the establishment of the London Wharfing and Warehousing Company, where special arrangements were adopted by means of which the temperature was kept down to 62° F. in the very hottest weather, the loss from evaporation was fully nine per cent.

HINTS ABOUT HORSES.

IT costs more to keep a poor horse than it does to keep a good one.

Change the feed for your horses often enough to make them relish it.

Improper feeding is the cause of nine out of ten cases of sickness among horses.

Every time you worry your horses you shorten their lives and days of usefulness.

Sweat and dust cause the horse's shoulders to gall. So do poor, ill-fitting collars.

The temperature of water for horses is not so much of an object as the purity of it. While it is best to have the water cool, it is more important to have it free from all impurities.

Mares in foal should have exercise and moderate work, and under no circumstances should they be subjected to harsh treatment, nor should they ever be allowed to go where they would be in danger of being frightened.

The horse which can plow an acre while another horse is plowing half an acre, or that which can carry a load of passengers ten miles while another is going five, independent of all considerations of amusement, taste, or what is called fancy, is absolutely worth twice as much to the owner as the other.

CHART OF A HORSE, SHOWING AT A GLANCE MANY OF THE DISEASES TO WHICH IT IS SUBJECT.

KEY TO THE ABOVE CHART.

1. Caries of the lower jaw. 2. Fistula of the parotid duct. 3. Bony tumor of the lower jaw. 4. Swelling from pressure of the bridle. 5. Poll-evil. 6. Inflamed parotid gland (commonly called mumps). 7. Inflamed jugular vein. 8. Fungus tumor, produced by pressure of the collar. 9. Fistulæ in the withers. 10. Saddle gall or sitfast. 11. Tumor of the elbow (shoe boil). 12. Hardening of the knee. 13. Clap of the back sinews (swelled sinews). 14. Mallanders. 15. Speedy cut. 15*a*. Splint. 16. Ringbone. 17. Tread on the coronet (caking). 18. Quittor. 19. Sandcrack. 20. Contracted foot (ring foot of a foundered horse). 21. Capped hock. 22. Sallenders. 23. Spavin. 24. Curb. 25. Swelled sinews. 26. Thick leg (caused by interfering). 27. Grease. 31. Rat's tail. 32. Injury from pressure of the girth. 33. Atrophy or wasting away of the muscles of the shoulder (Sweenie). 34. Shoulder joint lameness.—*Med. Classics.*

Affection cannot be pounded into animals. Kind treatment insures the affection of an animal, while rough treatment is sure to cause its hatred.

It is alike dangerous to other horses and men to spare the life of a glandered horse. Glanders is a highly contagious, incurable disease, and as a rule fatal in the human subject.

When horses are suffering from the bites of flies or stings of other insects, sponge the parts that cannot be protected by nets, with water in which insect powder has been mixed—a tablespoonful to two gallons of water.

Animals of vicious habits should never be used for breeding purposes, as vices are transmitted. By careful breeding in this respect, the dispositions of the animals can be partially controlled.

Of two colts similar in disposition and sense, one may develop into a steady and valuable family horse, while the other may be everything that is vicious, treacherous, and unsafe—all because of a difference in the men handling them.

Plenty of whitewash should be used, not only for the brighter appearance, but also as a disinfectant. Hot whitewash on the inside of barns, stables, poultry houses, and pig quarters will aid in preventing vermin and insects.

What the colt requires is plenty of exercise, a clean place to sleep, shelter from bitter storms, plenty of good grass of different varieties, good, clean hay without dust, and good, sound oats. Colts raised in this way will not look so well, nor win as many premiums, nor sell for as much money, but they will last.—*Med. Classics.*

CROCODILES IN A MENAGERIE.

AN exciting scene occurred on October 8, at Bone, in Algeria, at the aquarium—a sort of itinerant menagerie. The special feature of this aquarium consisted in a collection of no fewer than seventy crocodiles, which were fed publicly at stated hours by the manager, M. Pernolet. He always wore a pair of Wellington boots, and had a stick with which to beat off the reptiles when they became too ravenous, and attempted to snap the food out of his hands. On this occasion he was sitting on the back of his largest crocodile, and kept feeding the rest for about ten minutes, when, all at once, as he turned his head and put out his hand to the attendant for a piece of meat, one of the others crawled up to him and bit him in the stomach. A shout was raised by the spectators, and those around the tank tried to beat away the crocodile, which, notwithstanding M. Pernolet's blows, began whirling round his prey as if to tear him to pieces. Unfortunately, in struggling, M. Pernolet slipped, and fell in the very midst of the reptiles, which all rushed on him with fury. A panic took place among the spectators, who mostly fled. Nevertheless, M. Pernolet was rescued, and, although his wounds are serious, was expected to recover. Our engraving is from a photograph, for which we are indebted to Major-General H. G. Robley, taken before the above mentioned accident occurred.—*The Graphic.*

SLAUGHTER OF BIRDS BY THE STATUE OF LIBERTY.

SUNDAY night, October 7, says the New York *Sun*, was an unfortunate time for birds flying southward in the vicinity of this city. The great electric light in the torch of the Goddess of Liberty on Bedlow's Island lured hundreds of them to their death. Last year great numbers of birds were killed during their migratory flight, but this fall so far the record of the numbers killed is much greater.

A *Sun* reporter stood on the wooden platform under the goddess at about midnight, when the statue was surrounded by a perfect cloud of birds of many varieties. The electric burners placed in the angles of the old fort, for the purpose of lighting up the pedestal, formed a circle of light, after entering which few of the birds were able to escape. Many were dashed against the copper statue or the granite pedestal, and many exhausted themselves fluttering helplessly against the granite walls. Comparatively few flew against the glass bull's eyes in the torch. A strong northeast wind was blowing, which probably accounted for the fact that nearly all of the birds fell on the north and east sides of the statue.

After daylight on Monday morning, when the lights were extinguished, the birds were collected and counted. They numbered over 500, and twenty-five distinct species were counted. Nearly all of the birds were small, and most of them "yellow birds." The largest found were a red-headed woodpecker and two catbirds.

When the lighthouse keeper clambered up into the torch to replace the burned-out carbons in the lights, he found it filled with live birds, over fifty of which had flown in through the ventilators under the platform of the torch. They had to be caught one by one and removed, as they were too dazed by fright to fly out through the open door of the torch.

Five hundred is the greatest number of birds killed during any one night since the statue was erected. Last fall a newspaper contained a sensational article in which 3,000 were reported as killed, but 200 was, in fact, the greatest number killed in any one night of 1887. Last Thursday night over 400 birds were killed. Among the birds killed on Sunday night were eight English sparrows, the first birds of this kind to become victims.

THE ETIOLOGY OF RHEUMATISM CONSIDERED FROM A BACTERIAL POINT OF VIEW.

DR. MANTLE (*British Medical Journal*) points out that there are certain conditions of the body alike favorable to the development of rheumatism, scarlatina, and erythema nodosum. This, he says, argues that all these diseases are brought about by a similar poison. Holding these views, he set about making investigations in rheumatism. A drachm of serum was withdrawn, under the strictest antiseptic precautions, from the knee joint of a patient suffering with acute rheumatism. With this serum several sterilized tubes of gelatinized meat infusion were at once inoculated, and in each tube a copious growth took place. He had found two kinds of bacteria—a micrococcus and a small bacillus. Cover glass preparations of blood and serum showed micrococci as single cocci or pairs, and in acute cases zooglea masses; in addition, small, short, thick bacilli were also seen, either single, in pairs, or in colonies. These

FEEDING CROCODILES IN THE MENAGERIE AT BONE, ALGERIA.

bacteria were easily stained with methyl violet, with fuchsine, or by Gram's method. In two cases of purpura rheumatica he found no bacilli. In one case of gonorrheal rheumatism bacilli were found only in the blood. In chronic rheumatism and rheumatoid arthritis the bacteria were found. Might not the chemical products of these bacteria be lactic acid, and thus form the chief ptomaine of the diseases? The author found that cultivations of the bacteria of rheumatism, amygdalitis, erythema nodosum, and scarlatina produced lactic-acid fermentation in sterilized milk.

A POCKET CLINICAL PNEOGRAPH.

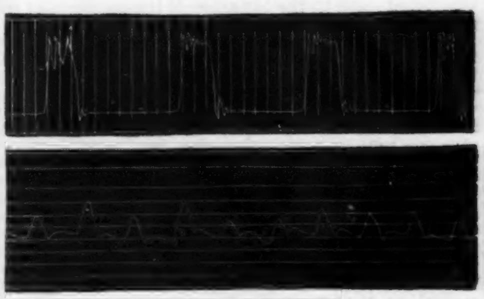
THIS instrument, devised by Dr. Mortimer-Granville, and manufactured by Mr. Weiss, consists essentially of a delicately suspended and counterpoised semi-disk (at present made of talc), which rises and falls when the instrument is held over the mouth of a recumbent person, or swings vertically when held in front of the mouth of a person sitting or standing. The rest of the apparatus consists of an arrangement similar to that employed in the sphygmograph, by which the

smoked paper is moved under a needle attached to the semi-disk. The result is a tracing comparable, as regards length and character, with the tracing made by the needle of the sphygmograph. The tracing of the pneograph shows the expiration by a more or less vertical line, the duration of the expiratory effort being indicated by the length of the line traced by the needle before it descends, at the moment when inspiration commences. The character of the expiration as regards force and continuity is shown by the nature of this line, and very notable and apparently significant differences are observed between the results obtained in diverse conditions of the lung.

The following tracings are given as examples of the results of the use of the instrument in a case of pleuro-pneumonia and in one of mitral incompetency:

Case of Pleuro-Pneumonia.

Respiration 38.

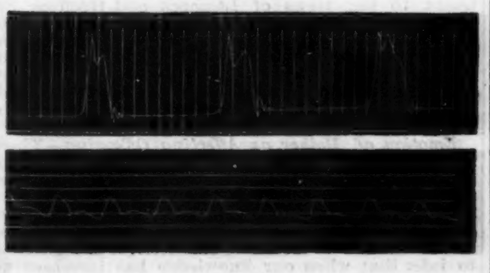


Pulse 102.

The vibrating lines at the head and base of the expiratory lines are produced by the force with which the semi-disk is moved by the breath.

The Same Case Sixteen Hours Later, Showing how Improvement is Indicated.

Respiration 30.

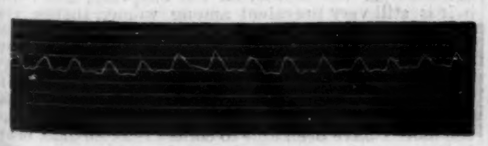


Pulse 96.

Case of (Probably Recent) Mitral Incompetency in an Otherwise Healthy Subject.

Respiration 18, feeble.

No. 1.



Pulse 160, Sitting.

No. 2.

Pulse 80, Lying.

The intermediate beat in No. 2 (which appears as a pulsation equal in height with the alternate beats in No. 1) is scarcely recognizable with the finger when the patient is lying, but feels equal in force when the patient is sitting.

We shall look forward with interest to the results of further experience in the use of this ingenious little instrument.—*Lancet.*

PNEUMONIA: ITS INCREASING DEATH RATE—ONE OF THE ESSENTIALS IN ITS TREATMENT.

A RECENT number of the *Medical Record* contains an interesting paper on the above subject, by Gouverneur M. Smith, M.D., of New York City.

Whatever doubts may be entertained regarding the specific cause of acute lobar pneumonia, there is no doubt in respect to the seasons of the year in which the disease is most prevalent in this latitude. The subjoined table, kindly furnished me by Dr. John T. Nagle, register of vital statistics in this city, clearly demonstrates the ebbings and floodings of a diseased tide, as it has disastrously flowed for the past decade through the calendar months of each year of that period.

Deaths from Pneumonia in New York City, by Months, etc.

Years and Months.	1887.	1886.	1885.	1884.	1883.	1882.	188'.	1880.	1879.	1878.
Jan....	460	387	375	348	357	376	366	261	341	280
Feb...	370	354	486	339	361	370	371	248	251	247
March	394	506	587	349	526	453	391	266	339	306
April..	466	374	512	304	472	393	393	375	274	249
May...	390	256	337	268	345	464	282	340	214	222
June..	164	184	229	186	213	234	178	163	126	143
July ..	137	176	150	167	133	169	151	127	103	84
Aug...	119	160	139	150	122	108	134	108	92	108
Sept .	205	135	149	156	127	135	157	184	114	106
Oct. ..	200	256	169	209	182	191	209	205	171	141
Nov...	347	378	217	298	240	225	254	246	268	181
Dec....	375	501	308	385	331	359	386	349	270	236
Total..	3,707	3,657	3,649	3,159	3,409	3,472	3,261	2,822	2,554	2,288

A glance at the table shows that the autumn, and specially winter and early spring, are in deadly alliance with the disorder. History is doubtless to repeat itself, and it requires no preternatural gift to prophesy that in many homes Christmas cheer and New Year and Easter greetings, now anticipated with pleasure, are to be interrupted by the ghastly intrusion of pneumonia.

Meteorologists classify the month of March in the vernal season, and, scientifically, it appears as a harbinger of flowers. Popular classification does not yield it any meed of praise as such a harbinger, but ranks the month as a ruthless, cyclonic Juggernaut. An inspection of the above table illustrates its mortal greed. There seems to be an untimely hitch between the meteorologists and the ordinary run of climatological observers.

With such important facts before them, it behooves physicians at all times, but specially each autumn, to examine their equipments, and find if they can improve their methods of smiting a disorder which annually proves such an inimical foe to mankind. The disease not only prevails extensively during the seasons designated, but also prevails most disastrously, its rate of mortality reaching a very high figure. The physician of to-day, when in attendance upon a case of pneumonia, is perplexed with anxiety in regard to the result, and consternation and dismay unnerve both the patient and the family. Such intense solicitude and affright are modern concomitants of the malady. A few decades ago the disease, while considered as a serious one, was not regarded with such appallment. Medical science has in many directions been making advancements in pathology and therapeutics, but, so far as pneumonia is concerned, science has shriveled, and the rate of mortality from the disorder has been increasing. This is an unpleasant fact to acknowledge, but it is, alas! too true.

Dr. Henry Hartshorne, in his paper read before the College of Physicians of Philadelphia, February 1, 1888, has so ably laid before the profession his views on the "Past and Present Mortality and Treatment of Pneumonia," that it is only necessary to briefly allude to the statistics he has gathered in relation to the subject.

In the Pennsylvania Hospital he has found that the death rate from the malady has augmented from 6¼ per cent. in the years 1845-46-47 to 18½ per cent. in the years 1865-66-67, and to more than 31 per cent. in 1884-85-86. He quotes from an editorial in the *Medical News* of December 11, 1886, that "the rate of mortality" of pneumonia "in the large general hospitals in this country is rarely below, more often above, 25 per cent., which represents about the average death rate from this disease in the Northern and Southern armies during the civil war." It is added that "in this country extensive statistics of pneumonia in private practice are not available, but in the recent returns of the Collective Investigation Committee of the British Medical Association, the mortality was 18 per cent." Dr. Hartshorne continues: "This last ratio, it will be perceived, is considerably more than double the carefully computed mortality of pneumonia before 1858, namely, 8·33 per cent. We have thus, I think, a *demonstration* of the large increase in the proportion of deaths from that disease, in recent times, over what it was thirty, forty, and fifty years ago."*

New York experience corroborates the statistics of Philadelphia. Mr. Joseph H. Vandervoort, assistant librarian of the New York Hospital, has kindly furnished me with a table showing the number of cases, the number of deaths, and death rate from pneumonia, occurring in the institution for a period extending from the year 1810 to 1887. As divided into decades, it appears from the table that the lowest mortality occurred between the years 1820 and 1830. The mortality has been rising, and during the last decade it reached its acme, more than double the earlier percentage. Any one at all familiar with metropolitan hospital affairs distinctly understands that hospital statistics cannot always be quoted as exemplifying the results of treatment unless the cases are classified. Many cases of sickness and injury are brought to a hospital in a moribund condition, treatment can scarcely be initiated, and, so far as the institution is concerned, they are really coroner's cases. Formerly, ships on arriving in port discharged their damaged and diseased crews into the wards of the New York Hospital, but, alas! too often in a plight kindred to that of perishable freight after a prolonged voyage. The modern hospital ambulance system, which is such a blessing to humanity, is doubtless often employed to foist into an infirmary dying cases. Many without friends, in lodgings, or among heartless friends or relatives, are shuffled to an institution to die, while in their last moments. Even if too late to be placed under regular treatment, such unfortunates, fortunately, find a final crumb of comfort—medical skill palliates suffering, trained nurses minister with gentleness, adieu to life is peaceful, euthanasia affording quiet birth into eternity.

Hospital statistics, therefore, in order to afford valuable scientific data, must be sifted, and classified in groups of cases. Without any such general and accurate figures to guide, as relating either to hospital or private practice in this country, but from such sources of inference as are at hand, and from observation, it is now an accepted fact that the death rate from pneumonia is much greater at present than it has been hitherto. Science and pneumonia have ever been at loggerheads, and the latter is vanquishing its pretentious foe.

Before coming to speak of the special point in treatment to which I wish to refer in this paper, a few initial thoughts may be appropriately interjected. It seems very conundrumical that so little use and mention are now made of means of relief which were formerly employed in the management of pneumonia, when it was a less deadly disorder. Fashion seems to have ostracised certain remedies and resources which apparently, at least, were benign in their action. The remedies were of modest chemical nature, as compared with their modern *elite* successors, but were, nevertheless, to the pharmaceutical manor born. Shoddy has undoubtedly in some instances superseded worth.

The use of the thermometer in disease has proved of great value in science, but since the abnormal rise of temperature has been specially noted, there has risen in therapeutics a potent fire brigade, known as the antipyretics. This brigade has a formidable enginery, and has largely supplanted the older febrifuges. The latter had some engines, which had to be used with great caution, but a number of them could be employed to refresh patients without the slightest risk of inducing mischief.

Metropolitan fire departments are splendidly equipped to master conflagrations. Alert insurance patrols are always on hand, however, not to quench flames, but to protect property from being destroyed by the zealously delivered deluge of the firemen. In medicine we have no equally alert protective insurance patrol—a puissant antipyretic, while quenching abnormal heat, may also extinguish the vital spark.

In the present fashionable catalogue of remedies are found oxydimethylchinizine and phenylacetamide, or acetanilide. These potentates figure aristocratically when associating with chemical companions, each syllable being a conferred degree of respectability, but when herding with drugs they appear each under a democratic alias, the former being known as antipyrine and the latter as antifebrine.

How do these and other modern *elite* syllables behave in the human economy as they whirl through the blood in accord with the cardiac rhythm? The ghost of Holbein suggests a "Dance of Death!" The ghost is as satirical as his old prototype, but, while the suggestion may be a vile innuendo, it, nevertheless, points to the necessity of extreme caution in exhibiting powerful remedies until after the most judicious observation such are found to be thoroughly reliable in safety and efficiency. Medicine has always been handicapped by its laggard branch of therapeutics. Chemistry has presented to science choice remedies, and is to bestow others vastly more valuable, but it must be remembered that among the originalities of the chemists an article may appear as a "Jekyl" on the shelf of the laboratory and as a "Hyde" on the counter of the apothecary. Recognizing the uncertainties attendant upon the use of drugs in the treatment of disease, it behooves the physician to place his patients, so far as it is possible, under the best hygienic conditions favoring recovery. Expectantly treating diseases under such circumstances is often most salutary. Lightning in summer strikes with a deadly celerity, and the chills and blizzards of winter smite the young, the feeble, and the old with almost equally rapid and ghastly strokes. Quite a number are so violently overcome as to succumb without an opportunity being offered for efficient medical interference; but quite a large proportion of cases of pneumonia are met with in which it is reasonable to anticipate an acute illness of about ten days.

People in health with two lusty lungs must breathe about eighteen times a minute to maintain the blood in a pure condition. Suppose, for a moment, that it was possible in a healthy person to plug a part of one lung, or an entire lung, or a portion of both lungs, in such a manner that the air could not enter such occluded parts. Suppose such condition was continued for a period of from seven to ten days, what would be the plight of such an individual at the end of this period, if the closed part of the lung was of any considerable size? Nature would probably try to adapt means to meet the situation; but nevertheless the sound person would become a patient, from a mechanical cause, and would show signs of suffocation, hebetude, and heart-failure.

In pneumonia we find a somewhat analogous state. One lung, a part of one lung, or of both lungs are involved in disease; engorgement, and hepatization, rendering such portions of the pulmonary tissue, for the time being, substantially useless for respiratory purposes, and neighboring portions are inclined to be cross

* The *Medical News*, Philadelphia, April 7, 1888.

and irritable. Complicating the situation, we find fever, more or less intense, and the abnormal heat frets the economy. Kidneys peevishly perform their work, springs, feeding the smaller and larger glands, run dry, and scorched nervous centers rebel. Co-operative disquietude is manifest in every vital atom, and, unless assuaged, a communistic strike, chaos—ashes to ashes!

Amid the bedlam, varying in degree with the extent of the initial lesion and collateral sympathy, one strong hope can animate the physician. In the natural course of events the pulmonary obstruction will disappear in a few days, and the lung or lungs gradually resume normal work. Can the patient be bridged to reach the climax? Can the uninvolved portions of the lungs respire sufficiently to maintain a tolerable condition of the blood until the critical period is passed? This is the great exigency—this is an absolute necessity.

It is clear that the blood requires aeration; can it be revived in any manner so efficiently as through the lungs, nature's method of arterialization? Can pill conceal oxygen, and smuggle through the gastric pouch life to the venous circulation? Can essence of ozone be given to substitute the process of respiration? Can any zephyred antipyretic essentially promote hæmatosis? Resources there are to palliate pain, relieve thirst, abate fever, and stimulate flagging energies; and all-important as these means are, they are almost insignificant as compared with affording pure air in superabundant quantity. While fresh air is essential in the management of all diseases, it is omnipotently indispensable in pneumonia, where the patient is using but a part of the breathing apparatus in the place of two lungs. It is more than ordinary ventilation that is required in such cases; what is needed is a persistent, systematic attention to a constant change of air in the apartment of the sick, by night, by day, each hour, each minute, and each second, and the twin companion of each one who enters the sick room should be a volume of genial, pure air.

Attention in the line above indicated should be excessive. Is such excessive care ordinarily bestowed upon the invalid? Trained nurses and affectionate relatives, while in a general way attending to ventilation, are contriving dishes, and with gentle hands administering comfort. But while with sympathetic smiles they may hope to cheer, and with kind words may encourage, their lungs are robbing the air of the apartment of its oxygen, and are vitiating the atmosphere. Friends, unwittingly, assume the role of foes. Sacred history records that when man was first formed, the Creator "breathed into his nostrils the breath of life"—kindred and attendants clustered around a loved one with the beneficent intent of preserving life, are breathing into his nostrils *the breath of death*. This need not necessarily be so. Freely admit the invisible friend, fresh air; it may as grandly revive the body as the invisible Spirit oftens brightens the soul under the same circumstances.

I have purposely omitted giving details in relation to the therapeutical management of pneumonia, wishing to confine my remarks to one point in its care which is imperative. I will not even venture to suggest methods of perflation, as rooms, and suites of apartments, according to their size, situation, etc., may have to be managed differently to secure the requisite result. The open fire prevents aerial stagnation. The sick chamber should be kept at an invariable and genial temperature agreeable to both the patient and attendants. In admitting pure air, perceptible cool currents are to be specially avoided. Eastern philosophy deftly says, "Draughts of air are arrows of death."

It is a very, very difficult task to secure the all-essential aerial purity, but without it the patient is liable to suffocation and to heart failure. Here an opportunity is afforded for ingenuity on the part of the physician and family; and when plans are devised for attaining such result, they should be specially intrusted to vigilant attendants, whose sole duty, if necessary, it should be to unremittingly carry them out.

I am tempted, and will venture, to make a digression, and give a hospital reminiscence of student life, which will illustrate a past and popular mode of managing the disorder, a method probably pretty generally in vogue at that time. In those days it was customary to give clinical bedside instruction in the wards of the New York Hospital, groups of students following the attending physician. Circles of two or three were selected to auscultate each patient; thus the invalid was not fatigued, and each disciple, in rotation, trained his ear to morbid sounds. The preceptor stated the stage of the disease, what was to be heard, foretold what was to be heard hereafter, and laid out the plan of treatment. The pupil did not learn that the disorder was extraordinarily fatal, and did not expect, on returning a few days later, to hear that the patient had succumbed, and to find the bed tenanted by another.

What means were then employed in treating the malady? Venesection, for the most part, had become obsolete. Wet and dry cupping and leeches were employed, as indicated by the condition of the patient. Poultices and oil-silk jackets were applied, and blisters were sometimes resorted to. In sthenic cases, minute doses of tartar emetic were exhibited, and in others spiritus Mindereri was given as a cooling draught, to which was added occasionally minute quantities of powdered ipecac to relax the skin and loosen pulmonary secretion. Dover's powder allayed pain.

In no inconsiderable number of cases, mercury seemed as a sheet anchor. Calomel in small doses, and guarded with opium, was administered at frequent intervals. The patient rapidly came under its influence. The dry mouth and tongue became moist, salivation was avoided beyond a genial moistening of the mucous membrane of the buccal cavity, which seemed also to extend to the vesicular structure of the lungs. On applying the ear to the chest, over the consolidated lung, one could hear it melt. Softened and loosened pulmonary secretion was freely expectorated, air again penetrated the lungs, and the ejection of sputa was favored by the use of Stokes' expectorant, with its stimulating carbonate of ammonia. While such remedies were being employed, fresh air, good food, and cordials, as required, were acting "*cito, tuto, et jucunde.*"

This reminiscence is given as a remembrance of bygone days, now sped a score and more of years. It is not presented with a view either of urging an adoption of a plan of treatment, or of contrasting such plan with methods which have since prevailed, or of debating the question of varying types of disease, etc., for the limits of this article forbid any discussion of such important subjects. It is simply recorded as an historical fact; there was no doubt regarding the diagnosis, and the death rate then was a little more than half of what it is at present.

In finally resuming the thread of my theme, it may be said that if physicians, while modifying their views regarding the methods of treating pneumonia, as it appears under varied phases and conditions, have failed to find infallible remedies for its relief, it is important that in one essential hygienic point of treatment they can at least agree. An agreement founded on truth can remain an eternal covenant.

Further reiteration seems unnecessary; but a few words in closing. It is clear, from what has been said, that in the treatment of pneumonia a superabundance of pure air is specifically indicated. The patient's breathing apparatus is only partially performing its functions, as the diseased parts of the lungs are substantially useless. The working portion must perform the work of two lungs, for a week or ten days, in order to maintain the blood in a proper condition to sustain life. The patient requires purer air and vastly more air than one in sound health. In estimating the amount of genial and possibly moistened air which should gently and freely pass through the sick chamber, allowance should be made both for the requirements of the patient and for the requirements of attendants. The latter should be as few as possible, in order to lessen the chances of aerial contamination.

Our atmosphere at times is harsh, but it always contains a life-giving element. When exposed to its inclemencies, care must protect from its bitterness, while extracting its sweetening oxygen. When admitted to homes, it can be artificially tempered as a boon to the shorn and to the unshorn. While remedies often behave benignly in the human economy, nevertheless, pure air, as a remedial agent in the management of pneumonia and of other disorders, both acute and chronic, has ever been a more important ally of therapeutics than any panacea offered by alchemy or any hobbiedehoy presented by modern chemistry.

Physicians will constantly meet with cases where, owing to the surroundings of the patients, it is impracticable to carry out the best methods of treatment. If a physician, however, through inadvertence on his part, allows a patient to die from want of fresh air, he deserves a stigma as ignominious, if not as heinous, as that which four centuries ago attached itself to Richard, Duke of Gloucester, for the crime of smothering princes in the Tower of London. History hisses through the ages!—*Medical Record.*

[Continued from SUPPLEMENT, No. 673, page 10756.]

ON THE CAUSES OF VARIATION IN ORGANIC FORMS.*

By C. V. RILEY.

Psychical—Use and Disuse.—Full consideration of the effect of use and disuse involves a discussion, not only of the question of the transmission of acquired structures, but of the influence of individual effort and of necessity, *i. e.*, a consideration of the essentially Lamarckian factors in evolution. The occasion will not permit me to do full justice to these subjects. That functionally-produced modifications are inherited was the great assumption upon which Lamarck founded his theory of evolution. Many able naturalists have insisted on it, and in my judgment there should no longer be any doubt whatever of the fact, not only so far as grosser structure is concerned, but brain structure likewise. No question is of more moment in the whole range of biology, and especially biologic philosophy, and Spencer has well pointed out that on the answer to it will depend largely the sciences of psychology, ethics, and sociology. Weismann, Lankester, and others deny hereditary power in such modifications, the former believing that hereditary modification can result only from changes in the *germ plasma*, *i. e.*, are virtually congenital. Natural selection, according to this view, plays upon the germ plasma; but I have never been quite able to comprehend how this view, even if established, militates against the transmissibility of acquired modification, for, whatever theory of heredity we adopt, it shows us rather the manner of the transmission, and therefore confirms its possibility. But the fact of such transmissibility rests neither on embryological nor theoretical grounds. It is a fact so fully demonstrated in the history of our domestic animals and the history of agriculture that the skepticism of some of our great naturalists and embryologists must be attributed to that ignorance of the farmer's commonest experiences which is, unfortunately, a too frequent attribute of the city-trained investigator. Darwin in the beginning, and while the importance of natural selection was growing in his mind, allowed little importance to use and disuse, for the same reason that he subordinated external agencies, viz., that, in proportion as it acts on masses simultaneously, it must diminish the importance of natural selection. Yet he allowed more weight to it toward the end, and has furnished some of the best evidence drawn from domestic animals of the transmission of acquired characters, affecting the dermal, muscular, osseous, and nervous systems. Spencer has shown that inheritance of functional modification is most easily observed and experimentally proved in those parts which admit of easy observation and comparison, as the dermal covering and the bones; and that they for the most part are beyond these tests in the muscular and nervous systems. Yet he logically concludes:

"Considering that unquestionably the modification of structure by function is a *vera causa*, in so far as concerns the individual; and considering the number of facts which so competent an observer as Mr. Darwin regarded as evidence that transmission of such modifications takes place in particular cases: the hypothesis that such transmission takes place in conformity with a general law, holding of all active structures, should, I think, be regarded as at least a good working hypothesis."

So far as entomology bears evidence, it confirms the fact that modifications of structure due to use or disuse on the part of the individual may be and are transmitted. These are easily observed in the exo-skeleton, and while the experimental proof is yet limited, it is not wanting, especially in the history of apiculture. Excessive use of any organ will develop or enlarge it at the expense of other organs, just as disuse will cause a diminution or atrophy thereof. The variation in the individual will be within limits, but when once the variation has set in, the tendency is always to an increased variation in the same direction in the descendants, especially if they continue the same use or disuse. Here, again, however, it is difficult to separate the modification due to individual effort, or want of effort, and the more general modification affecting the mass of individuals of a species through the environment; because the environment affects function, and function in its turn affects form and structure. The life of every individual furnishes an excellent illustration of new action and new uses for organs not previously used, in the striking and sudden employment of post-natal organs, both of respiration and nourishment, which pre-natally had no corresponding action.

Romanes has argued that *cessation of selection* may reduce an organ where use or disuse can have no play, as in the loss of wings in neuter ants; and that by the law of compensation an organ may even be increased, as in the heads of such neuters. He enforces the idea by exampling the blind crabs of our Kentucky caves, where the complex eyes rapidly disappear under cessation of selection, but where the persistence of the footstalks indicates that economy of nutrition could have had little play! It is difficult, however, to draw the line between this cause and Lankester's reversal of natural selection; and still more difficult to say where-in either differs from mere disuse.

Degeneration, which has been urged as the true explanation of many of the existing forms of life, is, it seems to me, but a consequence of disuse, and would therefore fall into the present category, among causes of variation.

Emotion as Affecting the Individual.—I have here considered the factor of use and disuse as a direct cause of variation, from the psychical rather than the physical standpoint, *i. e.*, individual or conscious effort as furnishing food for natural selection, among more highly endowed animals, rather than as effort by species as a whole necessitated by physical conditions and inducing modification in masses irrespective of selection. This leads us to the consideration of mind as a factor in evolution, and we shall soon see its importance as a fundamental cause of differentiation, among higher organisms at least. I am not sure, even, that its influence can be excluded from among lower animals, however much we may have to exclude its action in so far as plants are concerned; for any new functional effort inducing new use may be looked upon as conscious and intelligent as compared with use fixed by habit and lapsed into automatic action or instinct. The former typifies variability and progress; the latter, constancy and stability.

Mind is a comprehensive cause of variation, and may be considered under several catagories; we have, for instance, (1) the action of the mind of the individual in willing, or in selecting between differing alternatives that present themselves, as in the choice of means to ends; (2) the direct influence of the emotions on the individual; and (3) the influence of the emotions of the pregnant mother on her offspring.

In the first category the influence of mind in modifying is chiefly confined to man. It must have acted from the time when he first began to prepare his crude weapons of defense and offense to the present day, when some new discovery or some new invention may alter the map of the world, revolutionize society, or give one race or nation the advantage over another; nor can we feel sure that animals below man have not been modified by similar psychical effort. In the second category, the direct influence of the emotions on the individual, it is a psycho-physiological factor involved in the question of use and disuse; for if it be once admitted (and I think the tendency of modern neural science is in the direction of establishing the fact) that strong mental effort may be made to affect special parts of the body, *i. e.*, that an excess of nervous force brought to play on any particular organ or any particular part of the organism induces increased growth or development of such parts, we can understand how far desire, especially under the spur of necessity, may be influential in inducing modification. Lamarck's idea, therefore, may not be so ridiculous as it has hitherto been supposed by many. Darwin took no stock in this influence, and referred with some contempt to the views of Lamarck and Geoffroy St. Hilaire. He thought it strange that the author of "Les Animaux sans Vertebres" should have written that insects which never saw their eggs should will them to be of particular form, which he thought hardly less absurd than to believe that the desire to climb should make a Pediculus formed to climb hair or a woodpecker to climb trees.

Emotion of Mother as Affecting Offspring.—There may be some doubt about the extent of the influence of the individual mind in inducing direct modification, for the subject is a difficult one to deal with and we have few exact data to draw from. Since in human affairs we recognize the power of will in affecting purpose and action and in moulding character, it is legitimate to infer that when our knowledge has increased we shall recognize its effect on function. There can be less doubt as to the third category, viz., the influence of the mind or emotions of the pregnant mother on her offspring in inducing modification both physiological and mental. As a cause of variation, though believed in by J. D. Hooker, as we learn from the "Life and Letters," and by other of Darwin's contemporaries, it was discarded by Darwin himself, his principal reasons being that the results of observations made for him in hospitals were adverse to any such influence. Medical men, as a rule, also discard it as among the mere notions and superstitions of women, and argue its impossibility on the ground that there is no neural connection between mother and fœtus. The ancients practically recognized the influence of the imagination of the mother on her offspring, and belief in it is still very prevalent among women themselves, of all classes. Women alone are able to speak or feel in this matter, from experience, and the almost universal belief in the influence, among those who have any experience at all, should make us hesitate to discard it too summarily. From facts within my own personal knowledge I have long believed in this influence, and the more I have been able to collect reliable data bearing upon it, the more confirmed have I become in the

* Address by C. V. Riley, vice-president, section F, before the section of biology, American Association for the Advancement of Science, at the Cleveland meeting, August, 1888.

conclusion that the emotional experiences of the mother affect the issue in varying degree, according to the intensity of the emotion. When sudden and excessive, as in rage, fright, repugnance, etc., or where prolonged or accumulative, as in continued brooding, it may induce nervous disorders and even mental aberration, idiocy, or insanity; or, again, physiological change, as atrophy or increase of parts, and other peculiarities which have relation to the form or character of the inducing mental manifestation or shock in the parent. Investigation of this, as of all subtile phenomena, is attended with the difficulty of separating the chaff of fancy from the grain of reality. The method pursued by Darwin is unsatisfactory, as it dealt with moral conditions which furnish no evidence and with the fanciful or notional side of the subject. The literature of the subject is extensive and quite interesting, and I would refer particularly to the work and writings of Viellard, Schoenfeld, Demangeon, Lucas, Fere, and Brown-Sequard. Two other difficulties confront the investigator: first, the somewhat unsatisfactory state of neurology and the difficulty of experimental research therein, as indicated by Vice-President Bowditch before this section two years ago; secondly, the aversion, from feelings of delicacy, on the part of the persons concerned, to publicity of the more marked and striking evidence. The phenomena of hypnotism, proving as they do that physiological results may be induced through the imagination of the subject acted on by the mind of the hypnotizer, are suggestive in this connection, the work of Charcot in Paris more particularly showing how powerful the action may be and how the effects of actual medicines may be produced by the use of imagined ones. The mind of the hypnotized under these conditions is brought into those exceptional and exalted conditions which are necessary in the case of the mother to produce on her offspring the effect which we are discussing. The recent experiments of Mr. C. T. Hodge on the effects of stimulation on the nucleus and cell-body and on protoplasm are also interesting here, showing, as they do, decrease in the two former and vacuolation of the latter as the result.

The history of science is present to tell us that common and persistent belief, based on experience, has not infrequently been met with skepticism and even ridicule on the part of scientific men, only to be vindicated finally by more thorough and exact knowledge. It is too often the case that, where the processes are recondite and difficult to follow, assumption passes for knowledge. The function of some of our own bodily organs yet remains to be established, and we probably assume too much in requiring that all nervous force must be transferred through nerve tissue, or that there may not be protoplasmic filaments which are not resolvable, in their finer ramifications, even with our best microscopes. The very nature of mind and its processes puts it beyond the reach of the scalpel of the anatomist or the physiologist, just as many psychical phenomena baffle the exact methods of science, at least those so far employed. Leaving out of the question the evidence of peculiar marks due to maternal emotion, cases of which are part of the unwritten history of almost every family, the striking cases of which I have authoritative evidence of addition to, subtraction from, or singular modification of, anatomical parts, confirm me in the belief that this is a most important psycho-physiological cause of modification.

In the romance of Elsie Venner, in which the heroine's strange attributes are connected with prenatal influence of the mother, who died of the bite of Crotalus, Oliver Wendell Holmes has strongly put forth this doctrine in the form of fiction. I allude to this clever romance because of the medical knowledge of the eminent author, and because, while admitting in the preface that a grave scientific doctrine lies beneath some of the delineations of character, he also affirms that he has had the most startling confirmation of its truth. The data collected on the subject I hope to bring together on some other more fit occasion, and I would take this opportunity of urging any in my hearing or who may read these lines, if they have had or are aware of any authoritative and illustrative cases, to communicate them to me with as much detail as possible.

This theory once established, its bearing on evolution as a prime cause of variation must at once be manifest; for it gives not only tangibility to the Lamarckian idea of desire influencing modification, but, also, a conception of how infinite mind in nature may act through the finite in directing such modification. No doubt but that there is a great deal of nonsense and superstition mixed with the genuine, and that the idea that every little whim, or fancy, or imagining of the mother will produce record, or mark, is one of the unjustified outcroppings of the fundamental fact, and helps to explain the difficulty of getting at the real facts and the ease with which Darwin rejected the idea. In my judgment, this factor acts only when, from whatever cause, and particularly under the spur of necessity, the emotions are exceptionally intensified or the desire strongly centered in some particular object. The conception is perfectly legitimate, for instance, that when a species is subjected to any external modifying cause, affecting all its members alike, the adaptive modifications which natural selection, under such circumstances, would play upon have their origin in the emotions, or the influences at work on the pregnant females, giving direction in their offspring to the needed changes. In this way it is probable that only those individuals born under such conditions would be able to survive. Thus this becomes no mere ancillary cause of variation, but one of deepest import and at the very foundation of evolution. The female in this light acquires an increased importance, and evolution finds her not only the essential at the dawn of life upon our planet, but, in its present highest manifestations, she is nearest by instinct, intuition, and aspiration to the controlling mind, which in the beginning quickened the great womb of nature and down through all the ages guided the continuous stream of life to designed ends through the individual womb of the mother.

As already remarked, the psychical factors which we have been considering are substantially Lamarckian, and in proportion as we consider them and get to understand the other direct causes of variation, must we give importance to the ideas of Lamarck and, conversely, less importance to the ideas of Darwin.

Did time permit, I should like to go into an analysis of Lamarck's "Philosophie zoologique," and show how the genius of this illustrious French naturalist anticipated a very large part of that which Darwin subsequently so laboriously helped to establish. I must pass the subject, however, and simply record my surprise that one who was otherwise so honest and fair toward other writers was so evidently unfair in his estimate of the work of Lamarck, as Darwin, in the "Life and Letters," is shown to have been. It is incomprehensible, reading Lamarck with our present knowledge, that Darwin should have found neither fact nor ideas in a book which abounds in both, except on the theory of a poor translation or that strange national antipathy which has so often prevented the people of one country from doing justice to those of the other, and which so long prejudiced the French Academy against Darwin's own especial theories.

Darwinism assumes essential ignorance of the causes of variation, and is based on the inherent tendency thereto in the offspring. Lamarckism, on the contrary, recognizes in use and disuse, desire and the physical environment, immediate causes of variation affecting the individual and transmitted to the offspring, in which it may be intensified again both by inheritance and further individual modification. Both represent important principles in evolution and co-operate to bring about the results. The theory I propose gives renewed importance to the Lamarckian factors by showing one manner of their action not previously urged, and it also helps us to a tangible and scientific conception of design.

Acceleration and Retardation.—In this rapid glance at the immediate causes of variation we have discussed some factors which, in some degree, represent laws rather than inducing causes of variation. This difficulty appertains to all attempts at formulation of the causes of variation, and only as our actual knowledge increases shall we be able succinctly and definitely to classify the factors. There are, however, certain important laws which have influenced modification, but in no sense can be looked upon as causes of variation. They are laws or principles of evolution by which we may account for the formation of types, acting, just as natural selection does, in differentiating rather than in originating the variation. No one can have followed the important and suggestive works of Cope and Hyatt on the subject of acceleration and retardation and not feel that it expresses an important law of this kind. It is, as I understand it, a factor in evolution not comparable with the principle of natural selection, but complementary thereto, much in the same way as physiological selection and sexual selection are. It is an attempt to give expression and form to a set of facts to which paleontology undoubtedly points and which ontogeny substantiates, viz., that certain types may attain perfection in time and then retrogress and finally become extinct, and that existing types which are dying out, or degenerating, exhibit, ontogenically, the culmination of force and complexity, followed by decadence, corresponding to the phylogenic history of the type. We know, from the "Life and Letters," that Darwin gave up in despair the attempt to grasp the full meaning of these particular views of our associates, and in a letter to Hyatt, with characteristic modesty, he attributes this inability to his own dullness rather than to any weakness in the theory. Others have experienced the same difficulty, and believe, with Professor Morse, that the facts enumerated, as well as the facts of exact and inexact parallelism, are explicable on the doctrine of natural selection. This is true, it seems to me, only on the broader, unjustified interpretation of the doctrine to which I have previously alluded in the opening of these remarks. The law of acceleration and retardation may, perhaps, be substantially stated in this wise: that certain groups acquire some characters rapidly, while corresponding groups acquire the same characters more slowly, or never acquire them at all, and this brings us to another important factor of evolution which serves to give force to the law.

Acceleration by Primogeniture.—This has been elaborated by Hubrecht. He argues that so long as the parent form remained most in harmony with the surrounding conditions, it would maintain in the struggle for existence its characteristics against all tendency to vary in its offspring; which is equivalent to saying that it will remain unchanged so long as the environment remains the same. He then shows that in organisms in which the reproductive period covers many years, accelerated development by primogeniture, *i. e.*, as between the first born and the last born of any pair and of their posterity, will, in time, produce differentiation. The series of the first born will, in the course of time, involve many generations at short distances from each other, whereas the series of the last born will, on the contrary, consist of a much smaller number of terms each separated from its predecessor by a more considerable distance. Any tendency to variation from external or internal influences must needs find more numerous occasions to act in the series of the first born, not only because these have a more composite ancestry, but because they necessarily become the most numerous. In other words, the chances are more numerous for small differences among the first born series; and in proportion as such differences are accumulated, intercrossing and bastardizing with the series of the last born will become rarer. This law will gain from physiological selection, and, it seems to me, throws additional light on that of acceleration and retardation. It must act more particularly among higher animals, where the reproductive period is lengthened and the time between the first and last born is great.

Saltation.—We are thus led to what have been called saltations in evolution. Although the history of paleontology has continually added to our knowledge of past forms, and helped to fill up many gaps in the evolutional series, and although, during the last quarter of a century, it has particularly vindicated Darwin's prophecy that many links would yet be found, the substantial truth remains that gaps still occur, and that progress, so far as present knowledge indicates, has been made by occasional saltations. There have been, it would seem, periods of rapid movement, and of comparative repose, or readjustment of equilibrium. Cope concludes that "genera and higher categories have appeared in geologic history by more or less abrupt transitions or *expression points*, rather than by uniform gradual successions."

One of Pictet's strongest points, in opposition to Darwin's theory, which struck Darwin himself with much force, was that it ill agreed with the history of organisms with well marked and defined forms, which seem to have existed during but a limited period, as for instance the flying reptiles, the Ichthyosaurs, Belemnites, Ammonites, etc. Some authors, who have fully recognized these gaps or leaps in the developmental history of animals, yet believe them to be consistent with the theory of gradual modification. It may be only one individual of many which becomes modified and transmits the modification to descendants; it may be but one species of a genus which, for similar reasons, supersedes the rest, which become extinct in time proportioned to prolificacy.

There is no reason to suppose that the history of organic life has differed in this respect from that of inorganic. We need not discuss here the question of catastrophism and uniformitarianism in geology. However much the latter prevails at the present time, both have doubtless operated in the past. Catastrophism would necessarily produce gaps, or saltations, in the paleontological record, as only the more plastic species would adapt themselves and survive under its influence. It is not gaps due to such causes that are here to be considered, however, but those which occur in uniform strata. Haldeman has most suggestively remarked that the same mineral will crystallize with three, six, or twelve angles, but not with five or seven, and he asks: Are the facts of organic morphism subject to less definite laws? Cope has drawn another illustration from inorganic forces, in the three great changes in water, from solid, liquid, and vapor, which take place suddenly at what may be called three *expression points* of the thermometer, the many intervening degrees involving no change. Rhythm or wave movement would seem to be a universal attribute of matter, whether organic or inorganic. The forces of nature are constant, but the phenomena induced are often paroxysmal. The progressive forces accumulate, while the conservative forces resist, until at last resistance gives way with comparative suddenness. There is every reason to believe that the life movement, in its ascending complexity, has shared this common law. Accumulation is proportioned to the change in environment, and resistance to the age or rigidity of the organism. The latter may be strong enough to end in death or extinction, or it may break down and, with comparatively sudden yielding and conformity to necessity, burst the confines, and begin a new series of variations and adaptations. In either case we have breaks, because the dying or dropping out of one type makes room for another, more accommodating. Rapid evolution, from causes already discussed, implies gaps which must be marked according as the strength of the conservative forces and the violence of the final accommodation are great, and because sudden breaks are more apt to occur after long periods of stability. The break may be induced by changes in physical environment or without such change; if the latter, it will more likely occur in some individual, born with a marked departure from the type that gives it some advantage, and whose issue will in time supplant all other individuals. In either case, we shall have, paleontologically, distinct species or genera, one superposed on the other, without links. To the imperfection of the geologic record is to be attributed, no doubt, a large number of these gaps yet existing between types, and many important links, or branches, are yet to be discovered. Yet the views we have been considering should absolve evolutionists from all necessity of demonstrating the more minute gradations; because, in deposits like the Tertiary, during which we may assume life-conditions to have remained comparatively uniform, these saltations take place. Saltation, or, what is probably a truer expression, wave-movement, would indeed seem to be a prerequisite of progress, and will account for much that is going on even at the present day. In artificial selection by man we find that it is at first comparatively easy to accumulate minute peculiarities and variations by rigid breeding and exclusion of all deviation; but that we soon arrive at a fixed point, which is maintained at first with difficulty, but with increasing ease with each generation. During these more fixed periods the potentiality for change is doubtless increasing, until at last it is suddenly manifested in renewed variation. Rest is followed by activity just as surely as activity induces and requires rest.

There is a limit to development in organs, just as there is a limit to individual mental growth. Weariness of previous effort comes upon us when the limit of result is attained, accompanied by great longing for change, and not infrequently with revulsion from previous effort. The naturalist who has devoted a part of his life to the persistent accumulation of facts and specimens, has held the imaginative and generalizing powers in abeyance during that period. The reserve brain force in this direction may be suddenly called into activity by exhaustion in the other, and the process may perhaps be comparable to the exhaustion of the soil for one particular crop, without lessening its fertility for some other, the recognition of which fact is the foundation of all successful agriculture. Excess of development, whether in body or mind, inevitably brings about either wholesome reaction or utter collapse.

How far the rhythmic tendency in the development of animal life may be explained by the rapid change of climate, by migration and the loss of record, or upon the general law that while there has been progress of the whole, there has not necessarily been progress of every part, it would take us too far to discuss in this connection. I think we are safe in saying, however, that the facts justify belief that, in the evolution of animal life, as in the evolution of everything else, progress has often been made by waves.

The Fiskean Law.—With regard to what may be called the Fiskean law of correlation between brain development and infantile dependency, Fiske has so admirably elaborated the subject that it needs no further elucidation here as the principal factor in the evolution in man, first, of the family relation, then of the clan, the tribe, and the nation. With this factor in mind, and the immense superiority which anthropoid man must have had, when brain development had once induced this fundamental community of interest, over the rest of brute creation, the gap between primitive man and the higher anthropoid apes in the past or between the present lower races of man and the higher existing primates is easily explained, even if it had not been greatly exaggerated. At the present time we may note and record the further inevitable increase in the gap, for the lower races of man are gradually becoming extinct, and the higher apes cannot long hold their own or persist.

(*To be continued.*)

SKETCHES IN THIBET.

By Colonel C. J. Cramer Roberts.

The Himalayan mountain territory and small native state of Sikkim, adjacent to Darjeeling and Bhotan, on the northeastern frontier of India, was recently described as the scene of military operations conducted by Colonel Thomas Graham, Brigadier-General, to repress the Thibetan incursions. It was explained that the Rajah of Sikkim, whose feudal allegiance is divided between the British imperial government and the Dalai Lama or Buddhist ecclesiastical sovereign of Thibet, has a Thibetan residence at Chumbi, on the farther side of the frontier mountain range, and a Sikkim capital at Tumlong. We are favored by Colonel C. J. Cramer Roberts with a few sketches of Tumlong and the peculiar establishments maintained there, which have some interest from their Thibetan origin and character, and of which he writes to us as follows:

Tumlong, on the occasion of my visiting the capital of Sikkim, a few years back, I was much surprised to find a mere scattered collection of lamaseries or Buddhist monasteries on the hillside; among which the rajah's palace was distinguished by a copper gilt cupola on the top of its heavy thatched roof. It was surrounded by a more pretentious mud wall, inclosing the servants' or lay brothers' dormitories, the stables, and outbuildings. The main building consisted of the usual two-storied temple, the lower apartment forming a strange combination for devotional and secular purposes, as prayers and receptions are equally carried on here by the rajah and his head lamas. The upper room was almost a duplicate of the one below, except that it formed also a library, in which every volume of their sacred books had a pigeon hole to itself. The rest of the building consisted of dark passages and small dormitories, redolent of strange and powerful smells. I was fortunate in getting the head lama of one of the leading monasteries to have his portrait sketched, to which he willingly consented, on the distinct understanding he should be drawn in the attitude of prayer or blessing, being most particular that all his fingers were correctly represented, and that his acolytes or heralds should also be drawn in their picturesque caps and vestments, blowing conches, by which the faithful Buddhist far away on the mountain side is reminded of the hour of prayer. Occasionally they exchange these sea conches for human thigh bones, which are equally adapted as trumpets, and can be heard at a great distance. The last sketch of this series represents the great cane suspension bridge over the Teesta River, which on its way collects most of the tributary streams ever rushing down from the

1. Head Lama of the Changachilling Monastery at Tumlong, Sikkim. 2. Heralds of the Monastery calling out hours of prayer. 3. Light bamboo-cane bridge. 4. The Rajah's Palace, Tumlong, Sikkim. 5. Great cane bridge over the Teesta River.

SKETCHES IN THIBET, BY COLONEL C. J. CRAMER ROBERTS.

great glaciers of the Kinchinjunga range, and is even here a powerful stream, sweeping down everything before it—bowlders, giant forest trees—in its headlong course. This fragile fabric of a bridge, which appears as if the very winds could blow it away, is the only means of communication that the natives of this part of the country possess. It consists chiefly of tough wattles or small bamboos, closely interlaced, and capable of supporting two or three ordinary coolies with good heavy loads on their backs. But these bridges require a cool head to cross over them, as the footway is seldom more than six inches wide; in fact, were it not for the slender bamboo handrails, it would require the nerve of a Blondin to venture on such a spider-webbed concern, swayed about by the breeze over the torrent roaring below.—*Illustrated London News.*

WEIGELA (BUSH HONEYSUCKLE).

THE weigelas have long been in the front rank of flowering shrubs; they are deservedly popular everywhere, being elegant, rapid in growth, and beautiful when in bloom. There is now a multitude of varieties, the originals of which are W. grandiflora, known also as W. amabilis; W. rosea, W. floribunda, and W. hortensis. These type species are natives of China and Japan, whence they have been introduced within the last forty years. They have been so much hybridized that the original kinds are rarely found pure. The most valuable sorts have sprung from W. grandiflora, which has the largest flowers, while the smaller but more numerously flowered kinds have originated from W. rosea and W. floribunda. The varieties have been raised chiefly on the Continent, as may be inferred from their names. A selection of the best kinds of weigela

WEIGELA HORTENSIS NIVEA.

include the following: Abel Carriere, flowers small, very numerous, and deep red. Isolinæ, flowers large, white, or pale rose, with yellow markings. Van Houttei, flowers white and red, large and showy. Lemoinei, flowers small, numerous, deep crimson red. Groenewegenei, one of the best, the flowers being large, pale rose or pink, with yellow blotch. Striata, a very pretty sort, with flowers striped red and white. Stelzneri, flowers numerous, deep red. Lavallei, crimson red, and numerous. Hortensis nivea (see illustration), growth more spreading than that of others, foliage larger and paler, flowers large and pure white. Candida resembles the last, but is superior. These last two should always be selected, and if a larger collection is needed, the following may be added: Carminea, Emile Galle, Docteur Baillon, Edouard Andre, Aug. Wilhelm, Diderot, Montesquieu, and Desboisi. The golden-leaved W. Looymansi aurea is a very fine ornamental shrub that usually retains its bright golden foliage through the season, and the variegated-leaved form is also an excellent kind. All the above are of good habit of growth if planted in good soil in an open position to enable them to grow freely. They should never be crowded, their proper place being as isolated groups on lawns or on the margins of shrubberies. Where weigelas flourish they make large, symmetrically shaped specimens from 6 to 10 feet high and as much in diameter, with gracefully drooping branches, which, even when leafless in winter, are ornamental. Attention should be paid to top dressing them with good rich soil annually, and to pruning them well, so as to retain only the vigorous stems and branches that yield the finest bloom. Weigelas are now known botanically under the genus Diervilla, which also includes other species, D. sessilifora and D. trifida, from North America, being among them, but neither of these is, in its present stage, to be recommended for general cultivation, though they are worth planting on account of the bright tints of their autumn foliage.—*The Garden.*

THE FOUNDATION STONES OF THE EARTH'S CRUST.

THE Monday evening discourse during the recent meeting of the British Association was delivered by Prof. T. G. Bonney, D.Sc., F.R.S., who commenced an interesting lecture by asking, Do we know anything about the earth in the beginning of its history—anything of those rock masses on which, as on foundation stones, the great superstructure of the fossiliferous strata must rest?

Paleontologists, by their patient industry, have deciphered many of the inscriptions, blurred and battered though they be, in which the story of life is engraved on the great stone book of nature. Of its beginnings, indeed, we cannot yet speak. The first lines of the record are at present wanting—perhaps never will be recovered. But apart from this, before the grass and herb and tree, before the "moving creature in the water," before the "beast of the earth after his kind," there was a land and there was a sea.

Do we know anything of that globe, as yet void of life? Will the rocks themselves give us any aid in interpreting the cryptogram which shrouds its history, or must we reply that there is neither voice nor language, and thus accept with blind submission, or spurn with no less blind incredulity, the conclusions of the physicist and the chemist?

The secret of the earth's hot youth has doubtless been well kept. So well that we have often been tempted to guess idly rather than to labor patiently. Nevertheless we are beginning, as I believe, to feel firm ground after long walking through a region of quicksands; we are laying hold of principles of interpretation, the relative value of which we cannot in all cases as yet fully apprehend—principles which sometimes even appear to be in conflict, but which will some day lead us to the truth.

The name Cambrian has been given to the oldest rocks in which fossils have been found. This group forms the first chapter in the first volume, called Paleozoic, of the history of living creatures. Any older rocks are provisionally termed Archæan. These—I speak at present of those indubitably underlying the Cambrian—exhibit marked differences from one another. Some are indubitably the detritus of other, and often of older, materials—slates and grits, volcanic dust and ashes, even lava flows.

Such rocks differ but little from the basement beds of the Cambrian; probably they are not much older, comparatively speaking. But in some places we find in a like position rocks, as to the origin of which it is more difficult to decide. Often in their general aspect they resemble sedimentary deposits, but they seldom retain any distinct indications of their original fragmental constituents. They have been metamorphosed, the old structures have been obliterated, new minerals have been developed, and these exhibit that peculiar orientation, that rudely parallel arrangement, which is called foliation. That these rocks are older than the Cambrian can often be demonstrated.

Sometimes it can often be proved that their present distinctive character had been assumed before the overlying Cambrian rocks were deposited. Such rocks, then, we may confidently bring forward as types of the earth's foundation stones. I must assume what I believe few, if any, competent workers will deny, that certain structures are distinctive of rocks which have solidified from a state of fusion under this or that environment; others are distinctive of sedimentary rocks; others again, whatever may be their significance, belong to rocks of the so-called metamorphic group.

Our initial difficulty is to find examples of the oldest rocks in which the original structures are still unmodified. Commonly they are like palimpsests, where the primitive character can only be discerned at best faintly, under the more recent inscription. Here, then, is one of the best which I possess—a Laurentian gneiss from Canada. Its structure is characteristic of the whole group; the crystals of mica or hornblende are well defined, and commonly have a more or less parallel arrangement; here and there are bands in which these minerals are more abundant than elsewhere.

The quartz and the feldspar are granular in form; the boundaries of these minerals are not rectilinear, but curved, wavy, or lobate; small grains of the one sometimes appear to be inclosed in larger grains of the other. Though the structure of this rock has a superficial resemblance to that of a granite of similar coarseness, it differs from it in this respect, as we can see from the next instance, a true granite, where the rectilinear outline of the feldspar is conspicuous.

Here, then, is one of our problems. This difference of structure is too general to be without significance. What then does it mean?

Among the agents of change known to geologists, three are admittedly of great importance; these are water, heat, and pressure. The first effect of pressure due to great earth movements is to flatten somewhat the larger fragments in rocks, and to produce in those of finer grain the structure called cleavage. This, however, is a modification mainly mechanical. It consists in a rearrangement of the constituent particles, mineral changes, so far as they occur, being quite subordinate. But in certain extreme instances the latter are also conspicuous.

From the fine mud, generally the result of the disintegration of feldspar, a mica, usually colorless, has been produced which occurs in tiny flakes, often less than one-hundredth of an inch long. In this process a certain amount of silica has been liberated, which sometimes augments pre-existing granules of quartz, sometimes consolidates independently as micro-crystalline quartz. Simultaneously carbonaceous and ferruginous constituents are converted into particles of graphite or of iron oxide.

As to the effects of pressure when it acts upon a rock already crystalline, there are, as it seems to me, differences in the resultant structures which are dependent upon the mode in which pressure has acted. They are divisible into two groups, one indicating the result of simple, direct crushing, the other of crushing accompanied by shearing.

In the former case, the rock mass has been so situated that any appreciable lateral movement has been impossible; it has yielded like a block in a crushing machine. In the latter a differential lateral movement of the particles has been possible, and it has prevailed when (as in the case of an overthrust fault) the whole mass has not only suffered compression, but also has traveled slowly forward.

Obviously the two cases cannot be sharply divided, for the crushing up of a non-homogeneous rock may render some local shearing possible.

To sum up the evidence. In the oldest gneissoid rocks we find structures different from those of granite, but bearing some resemblance to, though on a larger scale than, the structures of vein granites or the surfaces of larger masses when intrusive in sedimentary deposits.

We find that pressure alone does not produce structures like these in crystalline rocks, and that when it gives rise to mineral banding this is only on a comparatively minute scale. We find that pressures acting upon ordinary sediments in Paleozoic or later times do not produce more than colorable imitations of crystalline schists. We find that when they act upon the latter the result differs, and is generally distinguishable from stratification foliation. We see that elevation of temperature obviously facilitates changes and promotes coarseness of structure. We see also that the rocks in a crystalline series which appear to occupy the highest position seem to be the least metamorphosed, and present the strongest resemblance to stratified rocks. Lastly we see that mineral change appears to have taken place more readily in the later Archæan times than it ever did afterward.

It seems, then, a legitimate induction that in Archæan times conditions favorable to mineral change and molecular movement—in short, to metamorphism—were general, which in later ages have become rare and local, so that, as a rule, these gneisses and schists represent the foundation stones of the earth's crust.

On the other side what evidence can be offered? In the first place, any number of vague or rash assertions. So many of these have already come to an untimely end, and I have spent so much time and money in attending their executions, that I do not mean to trouble about any more till its advocates express themselves willing to let the question stand or fall on that issue.

To a geologist (especially one belonging to the school of Lyell) it is equally difficult to conceive that there should be a broad distinction between the metamorphic rocks of Archæan and post-Archæan age, respectively, as that the pre-Tertiary volcanic rocks should be altogether different in character from those of Tertiary and recent times.

During the periods mentioned volcanic rocks appear, as we should expect, to have been ejected from beneath the earth's crust similar in composition and condition, and to have solidified with identical environment. Hence the results, allowing for secondary changes, should still be similar. But to assume that environment of a rock in early Archæan times was identical with that of similar material at a much later period is to beg the whole question.

My creed also is the uniformitarian, but this does not bind me to follow a formula into a position which is untenable. "The weakness and the logical defect of uniformitarianism," these are Professor Huxley's words, "is a refusal, or at least a reluctance, to look beyond the 'present order of things' and the being content for all time to regard the oldest fossiliferous rocks as the *Ultima Thule* of our science."

Now, speaking for myself, I see no evidence since the time of these rocks, as at present known, of any very material difference in the condition of things on the earth's surface. The relations of sea and land, the climate of regions, have been altered, but because I decline to revel in extemporized catastrophes, and because I believe that in nature order has prevailed and law has ruled, am I, therefore, to stop my inquiries where life is no longer found and we seem approaching the first fruits of the creative power?

Because paleontology is perforce silent; because the geologist can only say, "I know no more," must I close my ear to those who would turn the light of other sciences upon the dark places of our own, and meet their reasoning with the exclamation, "This is not written in the book of uniformity"?

To do this would be to imitate the silversmiths of old, and silence the teacher by the cry, "Great is Diana of the Ephesians."

What, then, does that physicist tell us was the initial condition of this globe? I will not go into the vexed question of geological time, though as a geologist I must say that we have reason to complain of Sir W. Thomson. Years ago he reduced our credit at the bank of time to a hundred millions of years. We grumbled, but submitted, and endeavored to diminish our drafts.

Now he has suddenly put up the shutters and declared a dividend of less than four shillings in the pound. I trust some aggrieved shareholder will prosecute the manager. While personally I see little hope of arriving at a chronological scale for the age of this earth, I do not believe in its eternity. What then does the physicist tell us must have been in the beginning?

I pass to the *consistentior status* of Leibnitz, when the molten globe had crusted over, and its present history began. Rigid uniformitarian though you may be, you cannot deny that when the very surface of the ground was at a temperature of at least 1,000° Fahr., there was no rain, save of glowing ashes—no river, save of molten fire. Now is ending a long history with which the uniformitarian must not reckon—of a time when many compounds now existing were not dissolved, but dissociated, for combination under that environment was impossible.

Yet there was still law and still order—nay, the present law and order may be said even then to have had a potential existence; nevertheless, to the uniformitarian gnome, had such there been, every new combination of elements would have been a new shock to his faith, a new miracle in the earth's history. But at the times mentioned above, though oxygen and hydrogen could combine, water could not yet rest upon the ruddy crust of the globe. What does that mean? This, that, assuming the water of the ocean equivalent to a spherical shell of the earth's radius and two miles thick, the very lava stream would consolidate under a pressure of about 310 atmospheres, equivalent to nearly 4,000 ft. of average rock.

Let us pass on to a time which, according to Sir W. Thomson, would rather quickly arrive, when the surface of the crust had cooled by radiation to its present temperature. Let us, merely for illustration, take a surface temperature of 50° Fahr. (nearly that of London), and assume that the present rise of crust temperature is 1° Fahr. for every 50 ft. of descent, which is rather too rapid. If so, 212° Fahr. is reached at 7,100 ft. and 250° Fahr. at 10,000 ft.

Though the latter temperature is far from high, yet we should expect that, under such a pressure, chemical changes would occur with much more facility than at the surface. But many Paleozoic or even later rock masses can now be examined which at a former period of their history have been buried beneath at least 10,000 ft. of sediment, yet the alteration of their constituents has been small; only the more unstable minerals have been somewhat modified, the more refractory are unaffected.

But for a limited period *after* the *consistentior status* the increase of crust temperature in descending would be far more rapid; when one twenty-fifth of the whole period from that epoch to the present had elapsed—and this is no inconsiderable fraction—the rate of increase would be 1° for every 10 ft. of descent.

Suppose, for the sake of comparison, the surface temperature as before, the boiling point of water would be reached at 1,620 ft., and at 10,000 ft., instead of a temperature of 250° Fahr., we should have one of 1,050° Fahr. But at the latter temperature many rock masses would not be perfectly solid.

According to Sorby, the steam cavities in the Ponza trachyte must have formed, and thus the rock have been still plastic at so low a temperature as 680° Fahr. At this period then, the end of the fourth year of the geological century, structural changes in igneous and chemical changes in sedimentary rocks must have taken place with greater facility than in any much later period in the world's history.

Then a temperature of 2,000° Fahr., sufficient to melt silver—more than sufficient to melt many lavas—would have been reached at a depth of about four miles. It would not be necessary to descend for at least 40 miles in order to arrive at this zone. During the 96 years of the century it has been changing its position in the earth's crust, more slowly as time went on, from the one level to the other.

There is another consideration. In very early times, as shown by Prof. Darwin and Mr. Davison, the zone in the earth's crust at which lateral thrust ceases and tension begins must have been situated much nearer to the surface than at present. If now, at the end of the century, it is at the depth of five miles, it was at the end of the fourth year at a depth of only one mile. Then, a mass of rock 10,000 ft. below the surface would be nearly a mile deep in the zone of tension.

Possibly this may explain the mineral banding of much of our older granitoid rock, and the coincidence of foliation with what appears to be stratification in the later Archæan schists, as well as the certainly common coincidence of microfoliation with bedding in the oldest indubitable sediments. I have stated as briefly as possible what I believe to be facts.

I have endeavored to treat these in accordance with the principles of inductive reasoning. I have deliberately abstained from invoking the aid of "deluges of water, floods of fire, boiling oceans, caustic rains, or acid-laden atmospheres," not because I hold it impossible that these can have occurred, but because I think this epoch in the earth's history so remote and so unlike those which followed that it is wiser to pass it by for the present.

But unless we deny that any rocks formed anterior to or coeval with the first beginning of life on the globe can be preserved to the present time, or, at least, be capable of identification—an assumption which seems to me gratuitous and unphilosophical—then I do not see how we can avoid the conclusion to which we are led by a study of the foundation stones of the earth's crust—namely, that these were formed under conditions and modified by environments which, during later geological epochs, must have been of very exceptional occurrence.

If, then, this conclusion accords with the results at which students of chemistry and students of physics have independently arrived, I do not think that we are justified in refusing to accept them because they lack the attractive brilliancy of this or that hypothesis or do not accord with the words in which a principle, sound in its essence, has been formulated. It is true in science, as in a yet more sacred thing, that "the letter killeth, the spirit giveth life."

A NEW TEST FOR IRON.

By F. P. VENABLE.

A SOLUTION of cobalt nitrate to which strong hydrochloric acid has been added is blue. It was noticed that when some impure hydrochloric acid was used, a green color was gotten instead of the blue. This change was traced to the iron in the acid, and as I have seen no mention of it elsewhere, I venture to give the present notice of this test. It is very simple, rapid, and delicate for detecting traces of iron, and is especially useful in testing strong acids. The delicacy of the test is such that, when even 3-100,000 of a gramme of ferric salt are added to the blue strongly acid solution mentioned above, the green is clearly given. With a somewhat larger amount this green is quite vivid. If too much of the ferric solution is used, the cobalt solution becomes pink from the addition of water. The test is not given by ferrous salts, nor does the presence of ferrous salts interfere with it. I have thought that the green was due to the addition of yellow ferric chloride to blue cobalt solution. Other yellow solutions which I have tested failed, however, to give the green.—*Journal of Analytical Chemistry.*

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.